COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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AIR LIFT PUMPING

BY JAMES P. GILLIES.

Most of the data which we have concerning the air lift are rather the results of direct experiment than of deductions from a scientific viewpoint. Air lift operations have never been plotted on curves, and the people who can best tell you how to obtain the finest results are those who have had the widest experience in pumping water by this means.

AIR LIFT REQUIREMENTS.

There are three principal things necessary for an air lift. The first and usually the most expensive of these is the well to yield the water; next the compressor to furnish the air to pump the water; and, lastly, the pipe to carry the air down and the water up. Each of these three, to give the best efficiency, must be of proper size and design.

THE WELL.

A most common mistake in the well has been the drilling it too small. A great many of the wells which are encountered start out bravely with a 10, 12 or even 14-inch hole and end up with 5, 4 or even 3-inch diameter. This is due to two causes. In the first place most of these wells were originally designed for the installation of a pump of the sucker rod and barrel type. The large hole was necessary for their installation, but the yield of the pump in proportion to the space it occupied was small and so a much smaller hole lower down was permissible. Secondly; in the process of drilling difficulties are often encountered which make it necessary from the driller's point of view to reduce the diameter. Later the water level dropped so, that the pump was no longer of service without reaming the well; or more water was required than the pump would yield and so the air lift was resorted to.

THE AIR COMPRESSOR.

A most important thing to begin with is the selection of a proper air compressor, and this must be determined largely by local conditions. It may be either of the straight line or duplex type with single or multi-staged air end. It may be either direct steam, motor or power driven. If steam, it may be either simple or compounded. If motor or power driven either direct connected or belted. Gear drive is not advised because of the nature of the duty to be met.

PIPING THE WELL.

The proper piping of the well is very important and it is here that experience and the intelligence or otherwise of the designer comes most into play. He must determine the proportioning of the air and water piping and the proper submergence at which to introduce the air into the water column, as well as the best method of doing it. There are three different methods of piping a well, as shown in Figures 1, 2 and 3. Figures 1 and 2 are those most commonly used. Where the well is large enough in proportion to the demand for water, No. 1 should always be used. Where the greatest possible yield of water for a given diameter of well is required than No. 2 is resorted to, but only at a sacrifice in operating economy.

AIR LIFT HANDICAPS.

It can be seen from the foregoing that there are a great many variables to be considered in the installation of a really efficient air lift.

*Paper before American Society of Brewing Technology, Chicago, Nov. 20, 1913. Somewhat condensed.

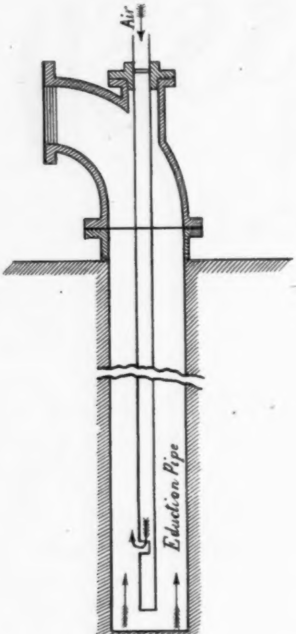


Fig. 2

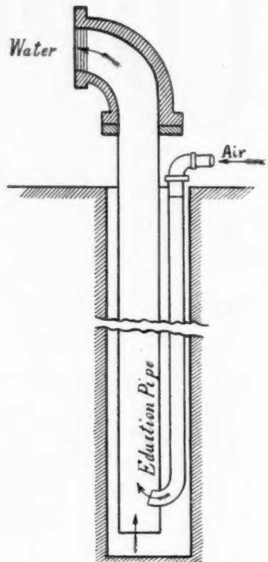
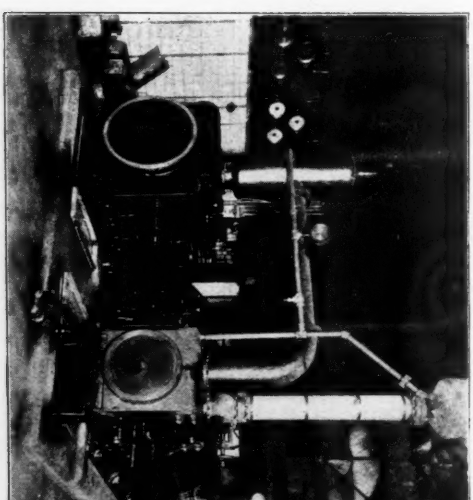


Fig. 1



COMPRESSOR AT SULZBERGER & SONS.

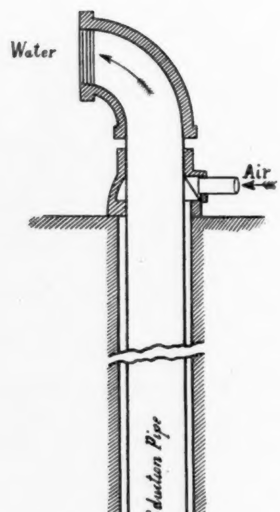


Fig. 3

This method of pumping has long been considered, because of its reliability and the general acknowledgment that it would obtain the greatest quantity of water from a given sized well. Even those who have installed it have, however, done it in an apologetic manner, making excuses for its inefficiency. This reputation is due to the fact, as already stated, that the air lift has been usually the last resort, installed under conditions that have handicapped it, whereas other systems of deep well pumping are given every advantage from the start. Then, too, with a pump it will either work as designed or not work at all, while the air lift will give some kind of result even when installed in a haphazard manner.

MODERN PRACTICE.

Within the last few years, however, the air lift has been coming into its own, until to-day those who know admit that, properly installed, the air lift compares very favorably in operating economy with any other method of deep well pumping. The high efficiencies now obtainable are due to the high state of perfection to which the air compressor has been brought, to the better method of introducing the air into the eduction or water pipe and to the proper proportioning of the pipes themselves.

DEFINITIONS.

Static head is the distance from the level of the water in the well to the well head or level of the ground when the well is not pumping.

Drop is the distance which the water recedes when the well is delivering a certain definite quantity of water.

Elevation is the distance above the well head to which it is desired to deliver the water.

Lift consists of *static head* plus *drop* plus *elevation.*

Submergence is the distance below the water level at which the air is introduced into the water column. It is styled either *starting submergence* or *running submergence*. The distance from the point where the air is introduced into the water column to the final point of discharge is considered as 100%. Thus 60% submergence means 40% lift, or 30% submergence 70% lift; the amount and percentage of submergence depending directly upon the height of lift. These different points are graphically illustrated in Figure 4.

THE MODERN AIR LIFT.

The modern air lift is so arranged that a

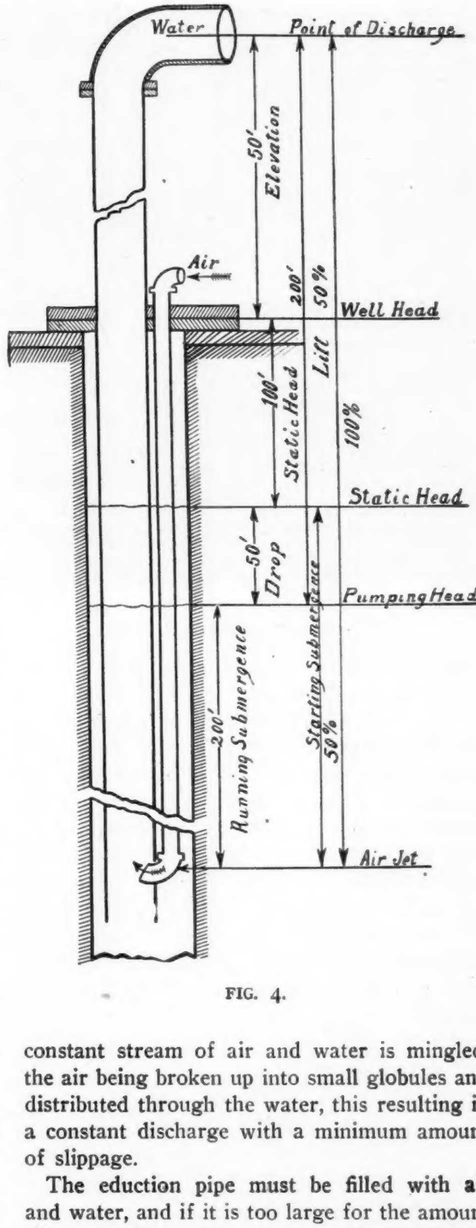
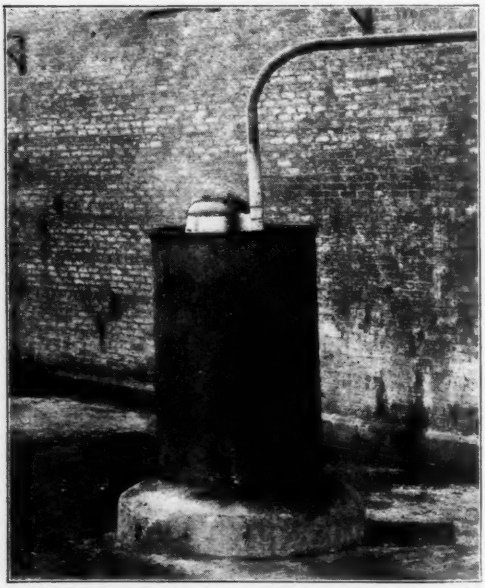


FIG. 4.

constant stream of air and water is mingled, the air being broken up into small globules and distributed through the water, this resulting in a constant discharge with a minimum amount of slippage.

The eduction pipe must be filled with air and water, and if it is too large for the amount of water, then a large amount of air must be used to keep up the velocity, the amount of water carried per square inch of eduction area may vary from 15 to 35 gallons, depending upon lift and percentage of submergence. While a 3-inch eduction pipe would be the proper size to carry 100 gallons per minute with a 100-ft. lift and 60% submergence, it would require a 3½-inch pipe to carry the



WELL AT SULZBERGER & SONS.

same amount of water with the same lift under 40% submergence.

This may be readily understood from the fact that the submergence regulates the pressure, the higher the air is compressed the greater its expansive properties, hence the less actual amount of air to do the work and the less room the air will occupy in the eduction pipe owing to its higher velocity. Now with the lower submergence and less pressure and a consequent lower velocity more air must be used, and more space occupied in the eduction pipe by the air on account of the lower velocity.

The eduction pipe should be a smooth tube. In screwing the ordinary pipe together the ends do not butt in the coupling, but a short space is left between the pipe ends; this tends to create a swirl and gives the air an opportunity to slide past the water, which it is always watching for a chance to do.

The air pipe to the well and down in the well carrying the air to the jet should receive due consideration. Every bit of energy used to compress the air to a higher pressure to overcome friction is just so much power wasted, and the extra cost of large air pipes is money well expended, for although the gain may be small it is constant, minute after minute, day after day.

INSTALLATIONS WITH HIGH EFFICIENCY.

We have, we believe, in the foregoing taken up the only real objection that has ever been successfully advanced against the air lift as a system of deep well pumping; that is, the prejudice that exists on the grounds of efficiency. Our contention that this prejudice is unfounded is borne out by recent modern, up-to-date plants that have been installed, such plants as Gottfried Brewing Co., Sulzberger & Sons Co., Jefferson Ice Co., and the plants of the Illinois Vinegar Co., all here in Chicago. In each case the water is lifted more than 200 ft. at a cost that equals the best practice by any other means and in quantities unobtainable under the conditions in any other way. Outside of Chicago such plants as those at the water works of St. Paul, Minn., Joliet, Ill., Fond du Lac, Wis., Plainfield, N. J., Dallas, Texas, and Montgomery, Ala., illustrate what fine results can be obtained with a properly installed air lift under varying conditions of lift and quantity of water produced.

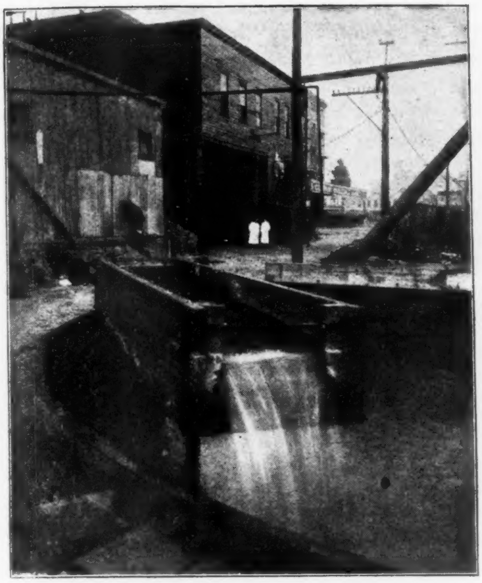
Having disposed of the question of the cost of pumping, let us now see what other points the modern air lift has in its favor, why it should claim your highest consideration.

COST OF INSTALLATION.

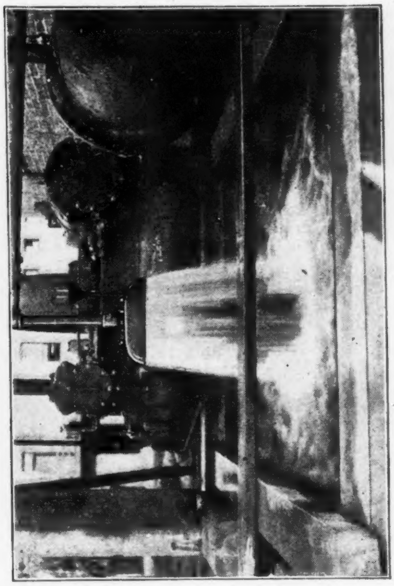
The first thing which occurs to most of us is the cost of installation. In this respect the cost of the air lift in small installations, say under 300 gallons per minute, is slightly in excess of that of other competitive methods; from 300 to 800 the cost is about equal, and above this limit the air lift has a decided advantage, even from this point of view. We are considering now, of course, the total cost of plant including the wells. This difference in favor of the air lift being due to the fact that fewer wells are required for an equal amount of water and assurance of continuous operation. The air lift is reliable; it's on the job all day and every day.

MAINTENANCE AND FLEXIBILITY.

Its maintenance cost is in marked contrast to that of the pump which handles the water directly and which of necessity must have its valves and packing continually renewed. The air lift once installed remains put indefinitely. Nothing comes in contact with the water except air and pipe. Its efficiency is maintained and the test conditions are the conditions of operation. The only machinery used is located where most suitable, under the eye of the operating engineer. Any number of wells may



WELL DISCHARGE AT SULZBERGER & SONS.



WELL DISCHARGE AT KNICKERBOCKER ICE PLANT.

be operated from the same compressor, provided its capacity is great enough, without regard to the location of the wells themselves. The modern compressor is enclosed, self-oiling, automatic in operation and requires the minimum of attention. When properly designed both the air and driving ends are highly efficient and economical of power.

THE AIR LIFT IMPROVES THE WELL.

With the use of the air lift the well is steadily improved and the flow increased. As far as this pump is concerned sand and solids in the water are no detriment. With the deep well pump of the rotary or reciprocating type foreign matter of this nature must be screened off and in time the well becomes clogged. The air lift draws out the sand and sludge, enlarging the water bearing cavities and so increases the flow.

To summarize: the air lift is above all reliable, inexpensive to maintain, reasonable in first cost, will obtain all the water a well will yield and improve this yield, and lastly, when compared with the true standard total over all cost year in and year out it is equalled by no other system. He who is confronted by the problem of obtaining water from a driven well is indeed fortunate if he can adapt his conditions to an air lift.

HANDLING MEN AND MATERIALS*

BY W. L. SAUNDERS.

The true way to handle men is to treat them as though they were men and not as servants. A wise manager appreciates and rewards good men and gets rid of bad ones. He is not there to conduct a training school in character or education. He takes men as they are and expects them to do the work that is put before them and to do it well. If they are incompetent and do not, after a reasonable time, improve, he is handicapping his organization by keeping them. If they are immoral, and by this I mean if they do not tell the truth, or if their habits are such that they lose time and work, he must get rid of them, even if it be only for the purpose of creating an example.

Above all things should a manager avoid patronizing his men. Anything that is obtained for nothing is usually not appreciated and is seldom worth having. Working men are usually intelligent beings who expect to receive a fair consideration for their labor. They do not ask for favors and do not appreciate them if they are given to them. A

*From address before the Graduate School of Business Administration, Harvard University, Sept. 26, 1913.

works under the influence of paternalism is not in a condition of permanent prosperity or efficiency. Welfare work is injurious if overdone, but it is very wholesome and proper when done in a practical way. Welfare work really means that it is the duty of employers of labor to provide means of comfort and safety for the men while at work. It pays to have the works clean and to have the best sanitary arrangements, to see that good air and water are available, that safety devices against injury are thoroughly installed, that immediate service is provided for the sick and injured, and that recreation and exercise are encouraged during vacation hours. When welfare work has been misapplied it has extended to giving food to the men free of charge, giving free tickets to entertainments and such-like. Men want a fair wage and with it they prefer to buy their own food and theatre tickets.

An excellent illustration of practical welfare work is in the Benefit Society, which has been established through so many organizations. In this society the men control the Board of Directors and the Company contributes a sum of money, say, equal to or greater than that contributed by the men. This Benefit Society takes care of the sick and injured and provides a substantial fund to the family of one killed at the works. Here is a spirit of co-operation between the employer and the employed which is far reaching in its effects throughout the organization. Such a system will not be a success unless the employer takes a liberal view of the situation. He must contribute liberally and he must recognize the right of the employes to run the society.

It is advantageous to make stockholders of the workmen. The more the stock of a corporation is distributed among its working force the more surely is the organization to prosper and survive. No stock should be given away, but the whole official family should have an opportunity to subscribe for the stock on a liberal basis, taking plenty of time to pay for it. This system is in use in several concerns that I am connected with, and it has worked beyond our greatest expectations. I have known of cases where good men who quarreled with others in the organization would have thrown up their jobs to the disadvantage of the company but for the fact that they held stock. I have also known a case where waste in the works was brought to the attention of the management by a workman who had one or two shares of stock and who considered himself a part of the organization. To bring a workman to this state of mind is the best possible condition, for it means team work akin to the effect of a foot ball team working toward a common goal.

HANDLING MATERIALS.

In handling materials in a shop it may be said in a general way that railway tracks should be provided only where the material is transported regularly and in volume from one definite point to another. If this is not the case, that is, if the material when partly finished is to be carried to another part of the shop, and so on, then the traveling crane can best serve the purpose of transportation. Traveling cranes for heavy product are of an enormous advantage in making for efficiency. It is a common mistake to economize, especially in foundries, by putting in a few cranes only, where money might be saved by multiplying the number of cranes, even though some of them are idle most of the time. It does not pay to have a gang of men waiting for a crane; it should be there when it is needed. The expense in interest on the investment is negligible compared with the time lost and increased cost of the product that results.

In large floor areas of the saw-tooth construction, or in cases where traveling cranes are not available, the trucking system is used. There has recently been introduced a form of truck which is so simple and which effects such a great saving on the floor that I shall call attention to it. At each machine tool a simple wooden platform is provided, on which the product which is to be carried away is laid. Several of these platforms may be around the same tool. A man goes about the works with a truck, which is so constructed that it is run underneath these wooden platforms and by a simple cam device lifts the platform from the floor and carries it anywhere about the works, depositing it and drawing out the truck for another load. This not only saves the labor of picking material from the floor of the shop and loading it on the truck, but it saves time lost in waiting for a truck to come around

It is always there in the shape of a platform.

Finally, let me call attention to the danger of over-capitalizing a manufacturing business. It is all very well at busy times to spend money on bricks and mortar. Manufacturers recognize the danger of not being able to supply their customers, but times are not always good and at depression periods interest and depreciation eat up profits. It is not difficult for us to think in our minds of large manufacturing concerns that have been brought, some of them, into the condition of receivership, by having shops that are too big an investment; that is, so large that the auditor in making out the balance sheet and figuring the interest and depreciation on the plant finds that instead of a profit there is a loss. There is such a thing as having the shop too big, and in some lines it is best to stop after reaching a certain point of size and to develop elsewhere, thus having two shops instead of one. A works may be too big for a single organization to efficiently handle. A man can do but one thing at a time and do it well. His capacity to look about the floor of the works is limited. If he has too much territory to cover he does not cover it all properly. Competing shops are advantageous in other ways. Managers compete with each other to turn out a better product and at a lower cost. This is the kind of competition, competing within one's own organization; a competition that is not destructive because the control is in the executive force of the company.

Two inventors, each located in different shops, are apt to vie with each other in making improvements in the product. Another consideration is that in time of strikes or other troubles, or in periods of depression, one shop may be closed down entirely and work concentrated upon the other.

WHAT IS "BAD" AIR?

A recent publication of the Smithsonian Institution by Prof. Leonard Hill and several others on "The Influence of the Atmosphere on our Health and Comfort in Confined and Crowded Places," makes some astonishing statements. It is said that the chemical content of the air in crowded places has nothing to do with its ill effects, that, apart from the influence of infecting bacteria, the ventilation problem is one of temperature, of relative humidity and of air movement. The percentage of carbon dioxide in the worst ventilated room does not rise above 0.5 or, at most, 1 per cent., whereas the normal concentration of carbon dioxide in the lungs is from 5 to 6 per cent. of an atmosphere. The writers adduce a great number of experiments and observations to prove that percentages regarded as deleterious or deadly by hygienists are quite harmless. They claim that it is also a fallacy to assume that a diminished amount of oxygen is harmful. At noted health resorts in the Alps the barometer stands at such a height that the concentration of oxygen is far less than in the most ill-ventilated room. One unfortunate result of this fallacy is that the laws regarding ventilation of mines insist on a high percentage of oxygen, and thereby increase the danger of mine explosions. Finally, the widespread belief in the presence of an organic poison in expired air is equally erroneous. The smells of crowded rooms and the like are no indication that the air is deleterious. "The deaths in the Black Hole of Calcutta, the depression, headache, etc., in close rooms, are alike due to heat stagnation; the victims of the Black Hole died of heat-stroke." This is rather more than is likely to be readily accepted.

THE LONG TUNNEL THROUGH SELKIRK RANGE.

Work on the construction of the tunnel through Mt. McDonald, for the Canadian Pacific Railway is now in progress. The tunnel will be a trifle over 5 miles long and will have a 1,700 ft. approach on the west side and a 2,600 ft. approach on the east side. It will lower the grade of the road 545 ft., will shorten the distance by nearly 4 miles; and will practically do away with dangers from snow slides. The portal of the tunnel will be 150 ft. wide by 40 ft., and it will be necessary to excavate 50 ft. before reaching tunnel grade. Before work can be started on the main tunnel the course of the Illesilletewait River for nearly a mile will have to be changed. In doing this the river will be diverted some 900 ft. to the left of its present course. Over 20,000 cu. yds. of concrete will be required for tunnel approaches and the tunnel proper. Foley Bros., Welch & Stewart, St. Paul, Minn., are the contractors. A. C. Dennis, Glacier, B. C., is in charge of the work for them.

USE OF SMALL ANIMALS FOR DETECTING POISONOUS MINE GASES

The following, concerning experiments conducted by George A. Burrell and Frank M. Seibert of the Bureau of Mines, we abstrast from a paper before the Coal Mining Institute of America, Pittsburgh, Dec. 4, 1913.

It has been found in general that the time required for symptoms of carbon monoxide poisoning to appear (or disappear) is proportioned to the respiratory exchange per unit of body weighed. The Bureau has experimented with most of the common small animals, and finds canaries and mice most suitable for the work. They are easily obtainable, and become pets of the men who have them. If handled intelligently they seldom die as a result of their exposure to carbon monoxide.

REPEATED EXPOSURE TO CARBON MONOXIDE.

Canaries, mice and guinea pigs were repeatedly exposed to carbon monoxide under different conditions. In some experiments they were exposed to atmospheres that distress them in about two minutes. In the case of canaries 0.25 per cent. was used in some cases and they were exposed 7 to 10 times, the object being to see if after many exposures they became to any extent acclimatized, and no such effect was noticed.

Animals were also exposed to percentages that quickly distress them, and after removal and recovery they were placed in atmospheres that ordinarily do not apparently affect fresh animals; this experiment was also reversed. It is possible that an animal which collapses at a certain place because of the proportion of carbon monoxide there, might upon recovery be used in an atmosphere containing a proportion that does not usually effect a fresh animal. Again, the same animal might be exposed over several successive days while a mine was being explored. It is believed that the experiments performed show that animals will not become acclimatized to carbon monoxide under the conditions surrounding recovery work in mines, and thus become less useful or even a source of danger. It might be mentioned that this question has been raised several times in discussing the use of small animals for detecting after-damp in mines.

RELATIVE SUSCEPTIBILITY OF DIFFERENT ANIMALS

The Bureau performed many experiments to draw some conclusions regarding the effect on different animals of the same species of a given proportion of carbon monoxide. In general a given proportion affected different animals of the same species in about the same length of time, at least as far as the application of the results to the practical use of the animals in mines is concerned, but that once in a while an animal might behave in a markedly different manner from what is expected. This is truer of mice than of canaries, yet even in the case of the latter several of them should be taken with an exploration party in order to prevent any possible errors.

RELATIVE EFFECTS ON MEN AND ON SMALL ANIMALS.

In reading over accounts of rescue and recovery work in mines, one is impressed with the fact that some users of small animals have not been entirely satisfied with the behavior of mice and birds (especially mice) in that men have apparently felt distress before the animals became affected. The Bureau as the result of many experiments made to determine the resistance of small animals to carbon monoxide poisoning believes it has the data at hand which explain this dissatisfaction.

It was found, for instance, that almost all of the animals tried do not show sufficient distress in one hour's time with 0.10 per cent. of carbon monoxide to make them valuable for detecting this percentage of the gas. In some cases the length of exposure was extended to three hours without any effects being observed. In one case only was a canary affected in so short a time as 12 minutes by 0.10 per cent. of carbon monoxide. With another bird and the same percentage of carbon monoxide, distress was scarcely discernable in three hours. Only a disposition to remain quiet was observed. With 0.15 per cent. carbon monoxide canaries showed distress in 5 to 30 minutes. A mouse showed slight distress at the end of an hour. With 0.20 per cent. canaries responded in from 2 to 5 minutes except in one case (35 minutes). Three mice responded in 12 minutes, and a fourth one in 46 minutes.

FIG. I. AN ACTUAL OCCURRENCE IN A MINE DISASTER.

Haldane made many experiments with himself as the subject in determining the effect of carbon monoxide on men. He found that 0.12 per cent. causes a mouse to sprawl in 11 minutes. Haldane felt a slight tendency to palpitation in 33 minutes. In 90 minutes he had distinct dimness of vision and hearing and a slight tendency to stagger, besides abnormal panting when he stopped the experiment long enough to run up and down stairs. In two hours' time vision and hearing became markedly impaired and there was some confusion of mind. When the mouse was finally removed from the cage it could not move about. With 0.045 per cent. of carbon monoxide, Haldane did not notice any symptoms in the four hours that the experiment was carried on, but on running up stairs there was unusual panting, slight palpitation, etc. A mouse was not distinctly affected.

In defining the minimum harmful or poisonous percentage of carbon monoxide, Haldane states that 0.05 per cent. in pure air is just sufficient to produce in time very slight symptoms in man, and the same percentage produces very slight symptoms in mice. He states that 0.20 per cent. is very dangerous to man. With 0.05 per cent. and thereabout, Haldane finds that the gas finally begins to affect man and the outward signs appear in mice.

In connection with the laboratory experiments the author has made observations regarding the use of small animals in mines. One instance is noteworthy, as follows:

A mine fire recently occurred and a sample of mine gas was obtained that contained the following constituents:

	Per cent.
CO_2	1.10
O_2	18.61
CO	0.12
CH_4	0.42
N_2	79.75

This sample was obtained in a place where exploration work was being conducted. Canaries carried with the party were not affected, but two of the men complained of a bad headache. Later when they went to the surface they became ill. One was indisposed all the evening.

These facts, although they appear damaging against the use of small animals for the purpose proposed only militate in part against their usefulness. Such animals still remain,

in the author's opinion the best indicators we have of vitiated air in mines. Canaries will give ample warning of percentages of carbon monoxide immediately dangerous to men. Men cannot stand the exposure to collapse from carbon monoxide as animals can. Canaries and mice after distress and collapse recover quickly if exposed to fresh air, only a matter of minutes usually. In the case of men expposed to collapse, recovery is often a matter of days.

When the carbon monoxide content of an atmosphere is raised from 0.10 per cent. to say 0.15 or 0.20 per cent., the susceptibility of a canary or of a mouse to the gas is markedly increased, as judged by the action of the animal, so much more than in the case of men that a canary especially may show distress in five minutes, while a man may require 30 or more minutes. A man, if he exposes himself as long as this, however, may finally become very sick, and, if for longer periods, may become dangerously so.

An Illinois commission found it hard to separate effects on steel workers produced by bad living conditions from those produced on some of the men by carbon monoxide, although they were inclined to the view that carbon monoxide poisoning had considerable to do with the generally poor condition of some of the employees. The exact action of the gas in producing bad nervous disorders still remains somewhat obscure. Some do not believe the action so simple as to merely temporarily deprive the system of oxygen, as in the case of suffocation, although most of the good experimental evidence points to this view. Somewhat analogous is the case of men who work at high altitudes or who suddenly ascend to extreme heights in balloons, where the oxygen tension is very low. Different individuals also may be affected differently at high altitudes. No doubt in cases both of carbon monoxide poisoning and oxygen deprivation by other causes, the idiosyncrasy of the individual plays an important part.

As regards acclimatization to the gas, it has been strikingly shown that guinea pigs may become immune. The compensation found in pigs has also been in part observed in men. The red blood-cells increase to compensate for those put out of action by the carbon monoxide. How long this may continue without pronounced distress on the part of men is a question that requires investigation.

Repeated exposure to carbon monoxide may occur in the case of miners who do the shot firing. Blasting explosions always produce some carbon monoxide in coal mines. Men may return too soon to the working place (before gases have disappeared), to examine their shot, and thus expose themselves to percentages, usually smell of the gas. Where large shots are fired, where the ventilation is poor, and where the working faces are too far ahead of the last breakthrough, contact with harmful percentages of carbon monoxide and other poisonous gases may follow. Miners at some mines frequently go home sick from powder smoke. The general effect on them of such exposure cannot be anything but bad.

In the conduct of exploration work one sometimes hears it said that certain individuals of a party were able to withstand atmospheres that caused distress in other members of the same party. This may be true because some men are more affected than others by the same proportions of the gas, but one or two other causes must be kept in mind. After damp in different parts of a mine, sometimes in two places, quite close together, may differ much in composition, to the extent that at one place a very small and insignificant amount of carbon monoxide might be present, while at another place, close by, a harmful proportion might exist. One person in a party unknowingly might encounter the latter atmosphere while his comrades do not. Another reason usually less apparent to an exploring party has to do with the fact that the amount of carbon monoxide absorbed depends, of course, upon the amount of air breathed. A man at rest may breathe 7 or 8 liters of air per minute. By even moderate exertion this can be increased to 3 or 4 times that quantity. It follows that if one or more members of an exploring party work harder than others they will become poisoned more quickly than the others.

Fig. 1 is a scene at an actual mine disaster volunteers waiting at this point for helmet men to bring the injured out and watching the canary for assurance as to the condition of the air.

Fig. 2 shows two men equipped with Draeger rescue apparatus and one of them carry-

FIG. 2. MINE RESCUERS.

ing a canary. The cage is of special construction, the handle being a container of oxygen. After the bird is asphyxiated it is placed in the cage, the oxygen is released and the bird revives.

CENTRIFUGAL FAN PROBLEMS

BY L. B. LENT.

When the discharge from two or more centrifugal fans is delivered into a common discharge pipe, these fans are said to be running in parallel. The pressure in each case is that which one machine alone would develop, but the air delivered is the sum of the volumes discharged by each fan.

Running the discharge from several fans into a common main or header seems, at first thought, to be a simple matter of connecting the fans up in this manner; but one has but to try it to discover that operation under this arrangement is impossible except under certain conditions. The writer's experience may be typical and serve to point out the essentials of proper operation under the conditions.

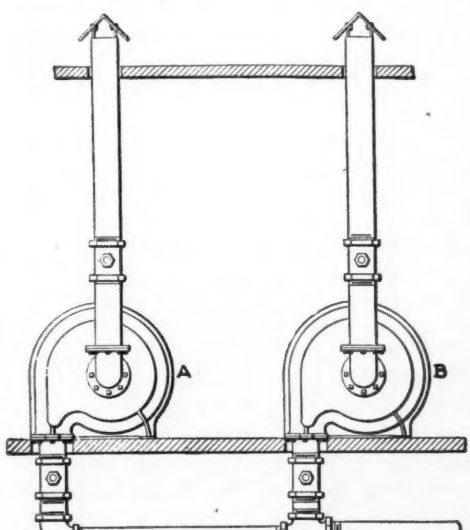
Two large single-stage turbine blowers were connected to a discharge main, as shown in the illustration. When first installed, one fan was sufficient to furnish the necessary air, at about 2 lb. pressure, to serve the oil burners in a number of metal-heating furnaces. The other fan served as a reserve unit and they were run alternately. A rapidly increasing demand for air made it necessary to run both fans together and, eventually, to add a third.

It was only necessary to start the second fan, the first one being already in operation, to discover that it would not deliver any air and that the first fan was actually blowing air right back through it. These two fans were of the same size, direct-connected to similar direct-current motors and ran at the same speed.

An analysis of the action of a centrifugal fan and the flow of air in pipes will show under what conditions centrifugal fans may be operated in parallel. Three facts must be clearly conceived and borne in mind. They are:

1. For a given fan the air pressure generated depends upon the peripheral velocity of the wheel or runner.

2. This pressure can be generated and maintained within the fan casing whether air is being discharged or not by running the fan up to speed with the discharge valve closed.



A FAN PROBLEM.

3. The total head of air in motion is the sum of two separate heads—the static head and the velocity head—the sum being called the dynamic head.

When air is under pressure in a closed vessel, a receiver, for instance, its pressure may be measured by a pressure gage or, if light, by a water column. This pressure existing in the quiescent gas is called the static pressure, and often its static head, being commonly expressed in pounds per square inch, in inches of mercury or inches of water. When air under pressure is flowing in a pipe, the velocity of flow is due to a drop in pressure and is proportional to a certain difference in pressure. The head equivalent to the velocity is commonly called the velocity head, and sometimes kinetic head. The sum of the static and velocity heads is the dynamic head.

When a centrifugal fan is started and brought up to maximum speed, with the discharge pipe entirely closed off the air in the casing is whirled around with the fan blades, and the static pressure measured in the discharge pipe is that due to the linear speed of the blades. With no air being delivered the fan will absorb only a small amount of power. It is only when air is actually discharged against a resistance that more power is absorbed by the fan. When air is rushing in a pipe the velocity with which it is rushing is equivalent to a certain pressure, and the velocity head is easily and accurately measured in units of pressure by means of the pitot tube.

An examination of air tables, referring to fan work will show that the velocity component is a considerable part of the total pressure. It is the velocity head, due to the inertia of the moving air, which must be dealt with when running fans in parallel.

Referring to the illustration, when fan *B* was running and delivering air at a static pressure of 2 lb., fan *A* was started and brought up to the same static pressure as fan *B*, but not a cubic foot of air did it deliver. On the contrary, air was actually flowing out of the intake pipe of fan *A*. The reason was, that the air being delivered from *B* was flowing at some velocity instead of being at rest and, consequently, had a velocity head in addition to a static head of 2 lb. If the velocity head be assumed at ½ lb., then the total or dynamic head of the discharge from *B* is 2½ lb. Since no air is really flowing from *A*, even though the wheel be running at a speed sufficient to generate a static pressure of 2 lb., the total head (static and velocity) at the fitting below *B* is greater than the total head (static only) existing at the outlet valve of *A*. As soon as the outlet valve of *A* is opened, the greater pressure will actually force air back through fan *A*. To make *A* deliver air, it is necessary to throttle the discharge from *B* until the dynamic head at *B* decreases to an amount equal to or slightly less than at *A*.

Some form of measuring instrument must be used to indicate the discharge from each fan, so that it may be positively known that each fan is delivering its proportion of the amount of air flowing. A simple instrument for such use is the pitot tube, arranged as a differential gage, and so indicating velocity only. There will always be a flow if a velocity is indicated, and if pipe sizes are proportional to the volumes flowing, the velocities from each fan should be equal. If, therefore, the readings from the pitot tubes from the discharge sides of two or more fans are the same, it is quite certain that these fans are delivering their proportional amounts of air.

When fans of different sizes and speeds are connected to deliver air to the same main, the problem of their parallel operation becomes more complex, but is based on the same equality of total or dynamic heads.

Starting up an idle fan and putting it into the line is, of course, the troublesome part, for, until air is actually flowing through and away from the fan, it has no velocity head. If it can be speeded up so that its static head alone is equal to the static and velocity heads of the fans already in operation, then the higher static pressure will start the air flow, and the speed must then be adjusted until the dynamic head is the same as that under which the other fans are running.

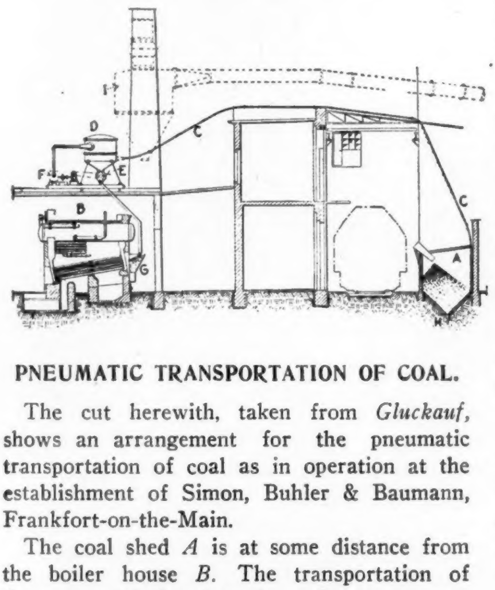
When the speed of the fan cannot be raised above that of the running fans, which is the more common condition of operation, then the dynamic head of the running fans must be reduced to equal that of the static head of the fan being put onto the line.

This operation, when there is more than one fan already running, is not an easy performance. Paralleling two fans is easy, but paralleling three is not. The usual type of inlet

and discharge valve furnished by the makers is some form of butterfly valve or slide gate, and a fine adjustment of the former is a work of art. A pitot tube on the discharge side of each fan with the gages so connected that the operator may read all from one point seems to be the most desirable arrangement, when it is necessary to parallel fans.

The usual method is to adjust inlet or discharge valves, and it is sometimes necessary to move fast from one fan to another, to get the fans together and to keep them together after they are in.

When positive blowers or compressors are discharging into the same line, the conditions are quite different and, up to the limit of the possible discharge pressures developed, each machine will discharge its proportionate share of the air.—*Power.*



PNEUMATIC TRANSPORTATION OF COAL.

The cut herewith, taken from *Gluckauf,* shows an arrangement for the pneumatic transportation of coal as in operation at the establishment of Simon, Buhler & Baumann, Frankfort-on-the-Main.

The coal shed *A* is at some distance from the boiler house *B.* The transportation of the nut coal in hand trucks or barrows across the shipping track was inconvenient, owing chiefly to blockage of the way by freight cars. The pneumatic system avoids this difficulty. A pipe *C* was run from the coal shed over the railroad track and storage building directly to the place of use. Above the boiler house is the vacuum receiver *D* with discharging device *E* and an electrically driven air pump *F,* so that the coal is brought directly into the hopper *G* in front of the automatic stoker. By means of the motor starter, the fireman in the boiler house can start or stop the transportation. Since the coal is bulky, the suction mouthpiece *H* in the shed cannot automatically suck it up as in the case of grain and other granular material, but a special arrangement must be employed which enables a completely automatic service. In the transportation tube the coal moves with considerable velocity, and when passing curves, rubs on the tube walls. Curves are, therefore, to be avoided so far as possible, and where indispensable they should be gentle ones. Discharge tube and chute must be as short as possible.

The coal collecting in the vacuum receiver *D* sinks through a steep funnel bottom to the discharging device *E,* which cuts it off from the vacuum. It consists of a cell wheel turning at about 10 r.p.m., and emptying the coal in small quantities. The coal dust forming in the receiver is caught on screens and by shaking with a hand lever the coal is resized.

For large plants a wet filter is recommended, that is, a reservoir filled with water to a certain height. The air containing coal dust is sucked through and thus cleaned. The slime thus produced is drawn off into certain chambers, dried and briquetted.

The furnace can also be fed automatically by a chip or sawdust-conveying plant *I* of about the same power. The movement of the air is produced in the plant described by a rotary blower *F,* belted to a 6-hp. electric motor. The quantity of coal conveyed is about 6½ cu. yd. per hour.

The joint commission of the States of New York and New Jersey, which was primarily created to devise plans for bridging the Hudson, has been brought seriously to consider the alternative of tunnels under the river as highways for general traffic and travel by ordinary vehicles. This looks as if bridges over the Hudson, although talked of for many years, may never materialize. The satisfactory experience already had with passenger tunnels should go a long way toward creating confidence in vehicular tunnels. But perhaps the most conclusive argument will be the fact that while the estimated cost of a bridge at 59th Street is $42,000,000, two tunnels, one for movement in each direction, could be constructed under the river from about Canal Street, where it would be of the most use, for not over $11,000,000.

MITCHELL DUST CATCHER FOR STOPE DRILLS

BY CLAUDE T. RICE.

The success which has attended the use of the air-hammer stope drill in all kinds of rock has, one might almost say, revolutionized drilling practice in this country. Now, far the greater part of the ore broken underground, in the United States at least, is broken with air-hammer drills of the so-called stope type which are used alone successfully in the drilling of dry holes, although recently the plugger type has been improved so that, under certain conditions, that type of hammer drill can be used with marked success for the drilling of water holes. With this great increase in the number of dry holes that are drilled is sure to come increased trouble due to miner's consumption unless something is done to prevent contamination of the mine air by the dust from the drilling.

There is an important difference between the drillings coming from a hole put in by a piston machine and those from one put in by an air-hammer drill. The piston drill hits a harder, slower blow, and therefore tends to chip the rock more than does the air-hammer drill. On the other hand the air-hammer drill hits a much more speedy and quicker, but lighter blow, than the piston drill, and tends more to mash the rock than cut it, so that, of necessity, the drillings coming out must be finer, and therefore more apt to float around for a considerable time in the air, than the heavier drillings. But in either case the air is badly polluted when an upper is being drilled in dry ore with either type of machine, unless some means of preventing dust pollution is provided. This fact that more dry holes are being used in breaking the ore, and that these dry holes are being put in with the type of drill that makes the most dangerous kind of dust, must in the end cause a decided increase in the amount of miner's consumption.

Three methods have been tried in preventing the rock drillings from contaminating the air of the workings. The first has been to squirt water into the hole as near its bottom as possible so as to wet the dust down before it gets out of the hole. The second method has been to dampen the dust just as it comes out of the hole either by a spray, or else by a wet sponge against which it has to impinge, thus cleaning the air by a sort of scrubbing action. The third method has been to let the dust form and catch it in some trap or receptacle before it gets out into the air.

Probably the best way to allay the dust is by squirting the water right into the bottom of the hole through a hollow drill steel as is done in the water Leyner drill. When the water is squirted in along the sides of the hole there is a tendency for a collar of mud to form just beyond the range of the spray, and this interferes considerably with the discharge of the drillings. The objection to the use of a spray is that the miners get wet, and that, to a large extent, is the objection to all water methods of dealing with the dust from an "upper." The miners get wet, and then they have rheumatism. With the rheumatism a present evil, and the menace of miner's consumption a more distant danger, most of the miners oppose strenuously such methods of fighting the dust, and abandon the use of such apparatus as soon as they can. Where the water is squirted clear to the bottom of the hole the objection is not nearly so great as when the water is squirted into the hole with a tube that generally is kept at least a foot or so from its bottom, while the spray method is the one that is condemned the most of all.

The only way to avoid the use of water is to catch the dust. Recently, a dust-catcher for use with air-hammer stopers has been devised that is practical and successful. This dust catcher is the one devised by Thomas E. Mitchell, one of the mine superintendents at Butte, and is used with success at the Leonard mine, where it was worked out as to the details of its construction. Not only is it simple and practical, but it is also cheap and serviceable. Several other different types were tried before this was devised; several of them on the spray idea. But this is the only one that the miners have shown any liking for. The device has been in use upwards of a year now. In the stopes as well as elsewhere, indeed, the raise men will not work without it. There is no trouble in changing drills, nor is the dust catcher unhandy to set up at the hole. It is absolutely free from leakage, and so, as the dust can not work back along the drill steel, this dust catcher also has the considerable further advantage that it keeps the drillings out of the moving parts of the machine as well as out of the air of the mine workings.

As the accompanying illustration shows, the Mitchell dust catcher is a canvas bag that en-

velopes the drill steel. Putting off from the main body of the dust catcher is a smaller tube that discharges the dust into a bag. This bag is tied around the bottom of the discharge tube, either by draw strings sewed into the bag or else by an ordinary string. To keep the discharge tube from collapsing, it has some rings sewed into it to help hold it open, while longitudinal ribs are also used for this purpose. The only place that dust could possibly get out into the air would be right at the collar of the hole. But as the collar ring of the dust catcher can be made to set close up to the ground there is no trouble arising on that score. Leakage around the drill steel at the other end of the main tube is prevented by the seal that is provided to make just that occurrence impossible. The wear and tear on the contrivance, as can be seen, is not great, and the main deterioration would be through rotting of the fibre of the cloth by acid in the ore.

Rivetted to the iron ring of the collar of the dust catcher, which is hemmed into the cloth, are prongs of spring steel that go into the hole and grip the dust catcher to the ground. These prongs or horns are made to enter a hole as small as 2 ins. in diameter, yet they will grip the ring tightly in place in a hole as large as 3 ins. across. The hole has to be drilled to a depth of about 6 ins. before it is advisable to put the dust catcher on, although it can be used when the hole is somewhat shallower. The drill steel is then inserted into the body tube of the dust catcher and the bottom end secured tightly to the drill steel, the drill steel having in the meantime been inserted in the chuck of the hammer drill, and the air turned into the feed tube of the drill so as to hold the machine up there while the dust catcher is being adjusted.

The secret of the success of this device is in the method of sealing this joint between the bag and the drill steel, no matter what the type of steel used. The speed with which the bag can be fastened at its lower end is due to the fact that the ends of the cords which are used in doing the typing are gripped in triangular clips, such as are used on the suspenders of bib overalls. So the cords only have to be pulled down into the contracted part of the clips to fasten them securely from slipping. To loosen the tie on the dust catcher, so as to allow the drill steel to be taken out, all that is necessary to do is to give the ends of the cords a couple of jerks so as to get them out into the big part

THE MITCHELL DUST CATCHER.

of the clips; then the drill steel is freed. Were it not that a special lining is provided at the lower end of the dust catcher's body, the seal obtained would not be dustproof. But as in the Mitchell dust catcher a lining of sheepskin tanned with the fleece on is used at the bottom of the body tube with the wool turned toward the drill steel, the tightening of the cords at the bottom forces the wool to conform closely with the shape of the particular steel that is then being used in the hole, and thus any leakage of dust is prevented. Owing to the resilience of the wool there is no noticeable deterioration in the seal that is obtained even after the dust catcher has been used for a year or more. Indeed, it is upon this happy thought of using a piece of fleece to make the seal that the success of the Mitchell dust catcher depends. This use of the fleece as a seal on dust catchers has therefore been patented.

The drill steel is gripped tightly enough by the fleece so that the dust catcher follows up with the steel as it goes farther into the hole, until finally the canvas of the body tube is all bunched up around the collar of the hole. Then the drill steel feeds on through the fleece-sealed joint until the steel has been run clear out.

The air is then turned off from both the operating and the air feed cylinders, and the machine taken down. The drill steel can then be removed from the hole, the dust catcher being left hanging by the prongs from the collar of the hole. A new drill steel is inserted, the hammer drill put up into place, and the air turned on to the feed cylinder. Finally the cords for making the seal are pulled taut and clasped in the gripping clamps, and again everything is ready for drilling. Thus no matter whether a hexagonal drill follows a round drill, or a cruciform steel follows a drill or round section, a tight joint is obtained. Moreover, the change from one drill steel to another is easily and quickly made; even more easily than it would seem in a description of the different steps. Indeed, it does not take much longer to make the change with a dust catcher being used than when one is not used.

A CAREFULLY PLANNED AIR PIPE LINE

The half-tones, here reproduced from Engineering and Mining Journal, show the elaborate and somewhat unusual arrangements employed by the Witherbee-Sherman Company, at Mineville, N. Y., for installing the pipe line which conducts compressed air from the central air-generating station to the various mine entrances. The line has been built in two sections, the first being of 12-in. pipe and extending from the compressor house to the Joker power house, about 1300 ft. In this case the pipe was supported on bents made up chiefly of pipe, the pipe of the cap serving as a roller. The air pipe merely rested on the cap. As a result of bulging, set up by the linear expansion and contraction of the line, side motion on the bents resulted, and the line required watching to prevent the pipe from falling off the bents.

Increases in operations at Barton Hill necessitated an extension of the line to that point. The company, as the result of a property purchase, had come into possession of a large quantity of 7-in. and 8-in. pipe and the desirability of using this determined the diameter of the pipe in the extension rather than any calculations of volume, velocity and friction loss. The line is 4300 ft. long, 1000 ft. of this length being of 7-in. pipe. Concrete bents were used in general, spaced 20 ft., but in certain cases where greater height was desired to cross roads or because of topographic conditions and also because the

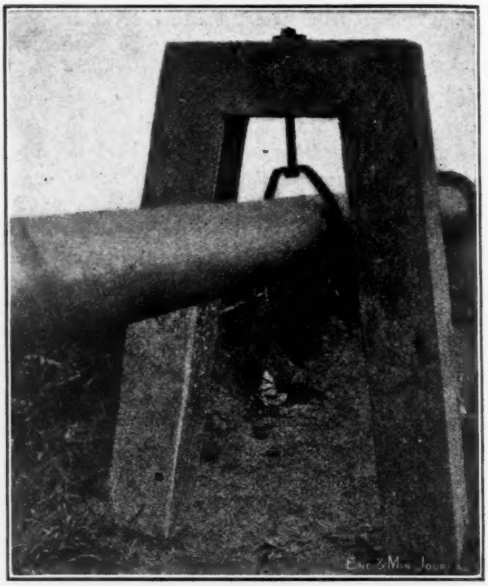


FIG. I.

waiting for the concrete to set introduced awkward delays at times, wooden bents were substituted. A series of such wooden bents on one side of a road is shown in Fig. 3.

The concrete bents, of which one is well shown in Fig. 1, were cast in place; there is a concrete sill or foundation in the ground to complete the bent. Reinforcement is obtained with two pieces of old 1⅛-in. cable, each piece forming a complete loop through the cap, legs and foundation sill, the ends overlapping in the sill. The average height of the concrete bents is about 4 ft. 10 in. To maintain grade for the pipe, bents of varying height were, of course, necessary. This was provided for by lengthening the legs of the forms. The legs and cap are about 8x8 in. in section, the sill is somewhat larger. The cap is 27 in. across the top. A vertical hole through the center of the cap permits the insertion of a ⅞x16-in. bolt with a rectangular ½x3x4-in. washer to bear on the concrete. From this bolt hangs the bridle shown, made of ½x2-in. material. A ⅞x12-in. machine bolt forming the bottom of the hanger, provides a bearing for the iron roller, on which the pipe rests. This roller has a concave surface, the concavity having a slightly greater radius than the pipe. It is 6 in. long, including one 1-in. projection on each end, which gives additional bearing. The

center portion is about 2 in. in diameter. The wood bents are also of 8x8 in. section.

The rollers permit of so easy a motion along the pipe line that provisions to take care of expansion need be inserted only at infrequent intervals. The ells at the corners, such as that shown in Fig. 2, serve this purpose and there are several of these, inasmuch as the line follows a rather tortuous course. In the longer straight stretches, and where necessary, slip joints are inserted and anchoring provided to control the pipe motion.

Concrete is extensively used by the Witherbee-Sherman Company, since the tailing piles furnish excellent sand and aggregate up to 2-in. in size. The substantial design of the entire installation is the result of a desire to keep maintenance charges at zero, an attempt that has been successful so far. The pipe and the wood bents are all well painted.

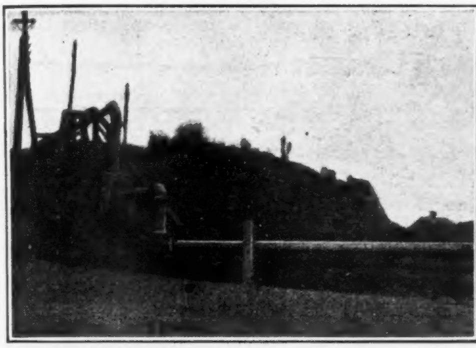


FIG. 2.

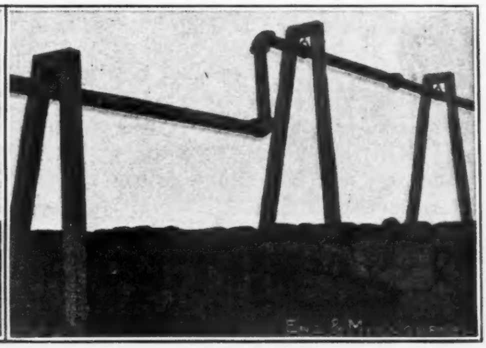


FIG. 3.

RELATIVE COST OF HAND, STEAM AND AIR-DRILL WORK IN CITY TRENCHES

The unit costs of drilling ledge and boulders in trench-work for sewers, water pipes, etc., and other construction work in city streets have always been high, because it is seldom economical to install a steam-power plant and piping for such small jobs, and drilling by hand in a large city where wages for labor are high is necessarily expensive. The advent of a portable air compressor (operated by electricity or gasoline engine) not too heavy to be moved easily from street to street has seemed to solve the problem of accomplishing this class of work economically. the cost per cu.yd. of rock excavation about

Based on hand-drilling costs, a standard rate of \$4 per cu. yd. has been allowed for rock removed within trench limits on water-main installation work in Boston, Mass. The amount allowed in solid rock per running foot in ordinary trenches for water pipe is 15 cu. ft. Actual costs of this Boston city work, sent us by Frederick I. Winslow, an engineer in the Sewer and Water Division of the Public Works Department, are as follows:

With a hand-drill the number of feet drilled in a working day of 8 hr. varies from 8 to 12 ft., the cost per day of the drill gang is \$7, the cost per lin.ft. drilled about 87c., and \$3.50. A steam-operated drill is capable of 50 to 70 ft. per 8-hr. day, the cost of operation \$12 per day, the cost per lin.ft. about 24c., and the cost per cu.yd. of rock excavation about 96c. A compressed-air drill is able to drill from 80 to 120 ft. per day, and the cost of operation, including an allowance for depreciation, repairs, moving, etc., is \$16 per day, the cost per lin.ft. about 20c., and the cost per cu.yd. of rock excavation about 80c. The difference in favor of the compressed-air drill is greater than the figures show, according to Mr. Winslow, on account of the greater ease of manipulation, and the fact that the compressor can be operated by unskilled labor.

The above costs for steam and compressed-air drills are based on but one drill operated from the power plant, although, of course, either type of plant is capable of operating other drills; with the small portable air compressor used two drills may easily be operated simultaneously.

DUNN PULVERIZED COAL BURNER

BY G. A. ROUSCH.

One of the most important improvements in the manufacture of Portland cement is the introduction of the powdered coal burner. Probably the best known installation for metallurgical work is at the plant of the Canadian Copper Company, Copper Cliff, Ont., where 50 tons of pulverized coal per day is burned in the reverberatory melting furnaces. It has been decided also to put powdered coal burners in the furnaces of the Anaconda Copper Company, at Anaconda, Mont.

The principle of the burner is to feed, by a screw or some other device, a continuous stream of powdered coal into a blast of air issuing from a nozzle at high velocity, and then to convey this to the furnace where the coal dust is ignited by the heat radiated to it from the walls of the furnace. The main difficulties encountered are the securing of a perfectly uniform feed of coal dust, and getting it evenly distributed and suspended in the blast of air. A form of burner which has practically entirely overcome these difficulties has been developed by Mr. William R. Dunn, Superintendent of the Vulcanite Portland Cement Company, Vulcanite, N. J.

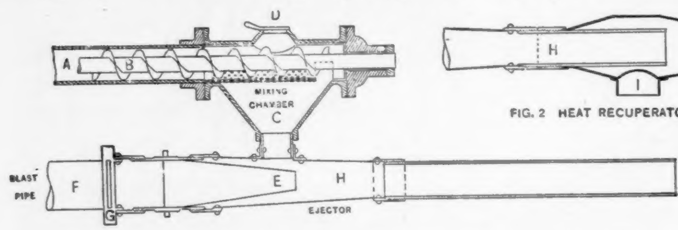


FIG. 1 PULVERIZED COAL FEEDER

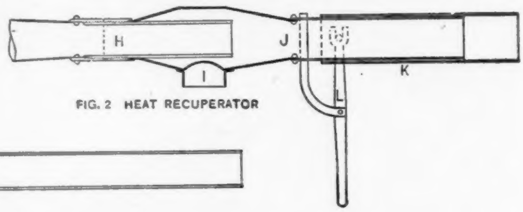


FIG. 2 HEAT RECUPERATOR

The construction of this burner is shown in Fig. 1. *A* is the feed pipe to the storage bin; *B*, the feed screw; *C*, the mixing chamber; *D*, an air valve; *E*, the air nozzle from the blast pipe *F*, the supply of air from which can be regulated by the gate valve *G*; *H* is the ejector to carry the mixed coal dust and air to the furnace. The important point in the construction of the burner is that, instead of allowing the coal to drop to the air nozzle just as it is fed by the screw, with more or less irregularity due to a slight amount of adhesion of the coal particles, the coal is carried along by the screw and gradually fed out through the perforations in the feed plate, the size of the perforations and the speed of the screw being so regulated that the coal just reaches the end of the perforated plate, for the maximum capacity of the feeder. This method of feeding completely does away with irregularities in the coal supply, and at the same time gives a more uniform suspension of the coal dust by drawing in a portion of the air through the valve *D* by the injector action of the air jet at *E*, the air thus drawn in mixing with the coal in the chamber *C*, instead of depending, for the entire distribution of the coal dust, on the action of the air jet from *E*. This uniformity of feed and suspension makes it possible to regulate the air supply very closely, so that only a small amount of excess air will be required by the combustion, and entirely does away with the "back-flashes" that result from lack of uniform mixing of the air and coal. By regulating the valves *D* and *G*, the proportion of the total amount of air required that is mixed with the coal in *C* can be controlled, as demanded by the composition of coal, and other conditions of combustion.

As applied to the cement kiln, the burner is supplied with the "heat recuperator" shown in Fig. 2. Only about two-thirds of the air required for the combustion is supplied at *D* and *G*, the remainder being drawn in through *I* by the injector action of the blast of air issuing from the ejector *H*. From *I* a pipe leads to the pit under the kiln into which the hot clinker is discharged, so that the air drawn in is slightly preheated. This of course amounts only to a small saving, but since the cost is no more, it is worth while.

The length of the pipe leading into the kiln can be regulated by the sliding sleeve *K* and the lever *L*. The distance from the kiln wall to the end of the pipe has considerable influence on the shape of the flame.

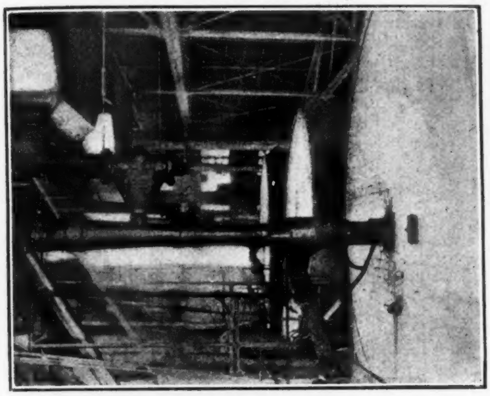


FIG. 3.

Fig. 3 shows an installation of these burners in the Vulcanite plant, burning 2600 lb. of coal per hour, in kilns 125 ft. long, 7 ft. inside diameter and 8 ft. 6 in. outside diameter, using an air pressure of 8 oz. and a coal, 94 per cent. of which passed a 100-mesh sieve. Sixty-foot kilns just beyond these were burning 800 lb. per hour. The flame was about 20 ft. long and the coal ignited at only 4-6 in. from the end of the ejector pipe of the burner. The stack gases left the kiln at 500-550 deg. C. The condition of the end wall of the kiln speaks for itself in regard to the absence of "back-flashes"; these always smut and blacken the wall, but this wall had not been whitewashed for over 30 months.

The substitution of these burners for oil burners in these kilns resulted in a saving of approximately 75 per cent. of the fuel cost in calcining, and at the same time, the capacity of the kiln was increased by some 25 per cent.

These burners are working satisfactorily in units as small as 50 and 75 lb. per hour, and it is thought that these smaller sizes can be successfully applied to steam boilers, with a considerable saving of fuel.—*Metallurgical and Chemical Engineering.*

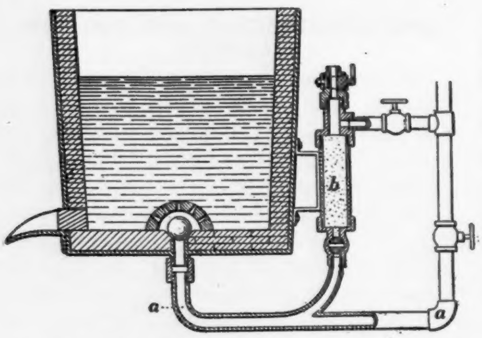
Condemned as useless only a few years ago, Eiffel Tower, the highest structure in the world, is now regarded as one of the most valuable of the possessions of France. It has made Paris the center of the wireless world. There would seem to be now good reason and strong incentive for the United States to build a tower much higher.

COMPRESSED AIR AT COST FOR MINE LESSEES

The mines of the Wolf Tongue Mining Company, in the Nederland tungsten field of Boulder county, Colorado, are operated under a leasing system, the company furnishing the equipment. To encourage the opening of the deeper ore bodies the company bears part of the expense of such development, paying the lessees $7 a foot for sinking. The company has just installed two electric driven two stage air compressors, 14x7½x10, and has laid pipe to the eleven mines on or near what is known as the Trevarthen ranch. The compressors can be operated either singly or together. The company will furnish the drills, charging no rental but the upkeep. For the air and sharpening the steel, it will charge at first a flat rate of $2 a day. As more lessees use the air, this rate will be lowered, and it is believed that for 10 drills it can be brought down to $1.25 a day. The purpose is to furnish the air at cost. All that the company expects to gain is an increased production. For the lessees it means a greater efficiency and larger profits.

MUNICIPAL AIR DRILL EQUIPMENT

The superintendent of sewers of Worcester, Mass., Matthew Gault, aims to keep at high efficiency the equipment used by the department. In 1912 a new blacksmith shop was built and supplied with modern equipment, and a complete new outfit was purchased for rock excavation. The forges are supplied with power blast. A 100-pound Fairbanks power hammer has proved very useful, as has also a Leyner drill sharpener which has a capacity of from 50 to 100 rock drills per hour. It is operated by compressed air furnished by a 9x8-inch Ingersoll-Rand compressor, which in turn is operated by a 20 horse-power electric motor. For rock work, especially in trenches, an 8x8-inch Ingersoll-Rand air compressor, geared to a 15 horse-power gasoline engine, both mounted upon trucks, has been purchased. They furnish sufficient power to operate two hand hammer drills using hexagonal hollow steel. The plant is portable and can be moved easily from place to place, and Mr. Gault says: "We are conservative when we say that for our work in narrow trenches this outfit has reduced by one-half the cost of drilling, as compared with the cost of steam drilling."—*Municipal Journal.*



DE-SULPHURIZING MOLTEN IRON WITH COMPRESSED AIR

The cut herewith shows the essential features of a process for removing sulphur from molten cast iron recently patented by W. F. Prince, foundry superintendent, Henry R. Worthington Company, Harrison, N. J. Ordinary compressed air is admitted through the pipe *a* into the bottom of the ladle. The cylinder *b* is used for holding the powdered alloys that it may be desired to inject into the metal with the air. The entire mechanism is attached to the ladle so that the reaction can take place as soon as the metal strikes the ladle and while it is being transported some distance to the moulds. The reaction which it is claimed takes place as the "air, gas or steam or other equivalent" comes into contact with the molten metal is that it oxidizes the manganese, creating manganese oxide, which, owing to its affinity, unites with the sulphur to produce a slag which rises to the top of the ladle or reservoir, where it may be skimmed off. During this operation a small quantity of the manganese unites chemically with the sulphur to form manganese sulphide, which rises to the top after it is formed by the agitation produced by the oxidizing agent.

CARE OF PNEUMATIC DRILLS

BY H. J. KIMMAN.

After running his locomotive from 100 to 150 miles a trained engineer climbs down from his cab and proceeds to count all the wheels to begin with. He feels all the rod connections and sees that they have oil, and if he has heard any untoward noise or clatter during his little trip he burns up the telegraph to tell his chief about it.

Now, the locomotive has not done so much of a stunt after all. It has only made about 30,000 turns, allowing for some slip, and, by the way, if the engineer slips it too much he gets a layoff. Now, a pneumatic drill is some machine when compared with this ponderous locomotive, to which some of the most eminent engineers in the world devote so much time and thought. A pneumatic drill in the hands of the most inexperienced help will, when used on reaming holes in this big locomotive's boiler make to exceed 1,000,000 turns in a day of ten hours, and no one to count the wheels. If a locomotive made a million turns it would have run 3,300 miles and spent about two weeks on the job, and half the time in the round house. The pneumatic drill is an engine, as fine an engine as any other type. Why not give it a little of the care which railroads are expected to give their engines? We believe it would repay you in service.

The price of your product, Mr. Manufacturer, to some extent depends on the endurance of ours. Why not strive by timely care and watchfullness to increase the life of ours and so cheapen yours. You may think that you give these drills the best of attention, but do you? The writer himself has seen many varities of the care that is bestowed on pneumatic drills. He has in mind a large shop, a sheet iron soft coal burning stove, both doors open and a nice big dirty fire inside immediately adjoining a rack on which drills are kept, the ashes from the stove covering the drills.

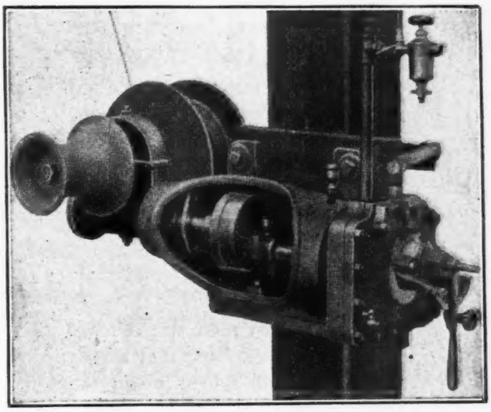
And now a word about grease. How long would a locomotive run if at uncertain intervals, averaging once a week, it was treated to a mess of grease of the consistency of putty (and just about as efficient as a lubricant). Grease with a fancy name and no lubricating value in proportion to its mass—grease which a shipbuilder would hesitate to smear his ways with for fear the ship would stick, and this little engine is expected to digest it or go without. We are not so old but what we can remember when a locomotive had a tallow cup and every time the engine stopped, the engineer would give it a dose of tallow, and it was nothing unusual for a shop machinist to find cylinder and especially valve seats honey-combed by the action of this tallow, and then it was chip and file to make a new valve face.

Now why expect of this little engine the things your big one could not do? An Eskimo thrives on tallow, a locomotive dies on it, and a pneumatic drill resembles a locomotive, not an Eskimo. It has a delicate appetite. It requires the best of heavy oil applied at frequent intervals, quite unlike the Eskimo who, when he eats, eats all at once and then perhaps not again for a week. Now, if you want the best work from pneumatic drills treat them right—give them the things they like. There may be cases when it pays to ruin a good machine to accomplish the work demanded of it; however, these are rare.

We have read of instances where riders have run a good horse to death, but accomplished the end aimed at. Under these conditions you do not blame the horse, while you praise the rider. You do not condemn a match after lighting has served its purpose. You are satisfied to throw away the stub. Now, when you work the little drilling engine as the horse or the match, that is to say, work it to death, why blame the machine if it has served your purpose as the match has. You have burned them both up, why not be consistent and when you say that this was a good match, also say "it was a good drill."—*Ideal Power.*

MOTOR SPIRIT FROM WASTE OIL

A process for the conversion of waste oil into motor spirit, and by which, according to Professor C. Vernon Boys, F. R. S., 43 per cent. of the original oil can be obtained, has been acquired by the British Motor Spirit Syndicate, Limited. The method consists of converting water into steam, which, at a temperature of 600 degs. Fahr., is brought into contact with the heavy oil to be treated, which has also been heated to a certain temperature. The steam and oil flow together through a series of heated tubes, in each of which there is a nickel rod. The steam, oil and nickel, when they meet, set up chemical action which drives the hydrogen from the steam into adhesion with the oil, so that the latter, which before treatment had an excess of carbon, has now an excess of hydrogen. This excess is sufficient to transform the heavy oil into a light oil or spirit. The gas can be used for providing heat for the retorts, while, on the other hand, the heavier oils are available for retreatment. The lighter oils make an admirable motor spirit. The process has been subjected to a test made by the Daimler Company, as a result of which Professor Boys states that the spirit is at least equal to petrol (gasoline) when used in a motor car.—*The Engineer, London.*



THE NEVADA WINZE HOIST

The half tone shows a power windlas for light hoisting, especially in mining work either underground or at the surface. It can be operated either by steam or air, the latter being of course the more prompt and ready in action without delay in heating up or to get rid of the water of condensation. It may be bolted to a post as shown or to a stull wedged in at any convenient place.

The drum is 11 in. diameter, 6½ in. between flanges, taking 5-16 or ⅜ in. wire rope. On the end of the shaft is a turned gypsey head to handle a fall—½ in. to 1 in. diameter. The shaft is driven by worm gearing with ball bearing thrust.

The motor is of the square piston type, developing 3 horse power with 80 lb. pressure. The control is by a single lever for stopping, starting or reversing, with accurate and delicate regulation of speed. A load of 450 lb. can be raised at a speed of 70 ft. per min. Materials, workmanship and lubrication details are all up to date. The hoist is built by the Nevada Engineering Works, Reno, Nevada.

German authorities are stating that in the commercial production of liquid air 1 h. p. hr. produces from 3 to 8.5 cu. in., according to the apparatus and arrangements employed.

COAL MINING WITHIN THE ARCTIC CIRCLE

At Tromso, Norway, 750 miles from the North Pole, there is a coal mine in constant and successful operation, although not upon a very extensive scale. The product goes to northern Norway and to Russia, and as the season of navigation lasts only four months there are two clamshell buckets, a Brown hoist and a Hayward, constantly employed either in accumulating piles of coal or in loading it on the ships.

The longest entry of the Arctic Coal Company's workings is over 2,300 feet, and although the miners are working at the face about 1,000 feet vertically below the surface they have not reached a depth to which the ice and frost has not penetrated. The highest rock temperature recorded in summer or winter is twenty-seven degrees Fahrenheit. At this mine the miners have never seen a drop of water or a trace of gas underground.

There are about 300 men employed at this mine throughout the year, and they are entirely cut off from the outside world during the winter months. In order to keep in touch with civilization, the company has installed a wireless telegraph station which receives weekly reports.

Besides the Brownhoist and Hayward clamshell buckets, this mine is equipped with a complete electric power station, and the camp and mine are lighted by electricity. The mine is being worked by the advancing long-wall method used electrically driven long-wall coal cutters built by the Diamond Coal Cutter Company, of England. The installation also includes Ingersoll-Rand temple electric-air drills, a Sullivan short-wall machine, and various other devices, all electrically operated by an A. C. current of 440 vots. On the surface there is also a Bleichert ropeway.

COMPRESSED AIR FOR CHIROPODISTS

Compressed air is a necessity to any up-to-date and fully equipped chiropodist. He has so many and such frequent calls for it, as told in Emerson's Monthly, that it would seem impossible to get along without it.

In the first place, as soon as a foot is presented to the chiropodist, he immediately sprays it thoroughly with some antiseptic solution, such as a 2 1-2 per cent carbolic solution, or a 1-2000 bichoride of mercury solution, thereby minimizing the danger of infection.

He begins to cut away the corns and other excrescences, and in so doing encounters one or more raised capillaries which immeditely begin to bleed—not copiously, but still enough to alarm most patients. If the chiropodist knows the ropes, he will at once apply the compressed air directly over the slight hemorrhage and in a moment or two coagulation will have set in, and the abraded skin thoroughly sealed before even the patient is aware that there has been a hemorrhage.

Compressed air is aseptic from the fact that micro-organisms cannot live therein, hence there can be no danger of introducing germs into the wound by the direct application of compressed air. Most chiropodists, after they have removed an ingrown portion of nail from the groove of a sore toe, insert pledgets of cotton therein for the purpose of absorbing the moisture and drying the groove. This in many instances is a painful procedure and could well be abolished, the same purpose being accomplished painlessly by simply blowing the compressed air into the groove. In an instant the groove will be dry in the same manner as a cold wind will dry the sidewalks after a rainstorm.

In cases of inflamed corn or bunion which have just been painted with iodine, the stream of compressed air blown thereon forces the medicament into the skin, with the result that the therapeutic action is quicker and more effective than if simply allowed to dry thereon. In abscesses or sinii, where a caustic such as pure carbolic acid has been employed to destroy the lining membrane, a most favorable result can be obtained by forcing a stream of compressed air into the cavities.

WE ARE WONDERING WHO IT WAS

The New York state law governing the conditions under which labor may be employed in an atmosphere of compressed air, has recently been radically amended by the Legislature. It is printed in the *Compressed Air Magazine*, October 1913, page 6998. A well known authority on compressed air engineering has called attention to two oversights in the amended law, in that it takes no account of the temperature nor of the breathable condition of the air as determined chiefly by the volume furnished.—*Robert Peele in Mining and Scientific Press.*

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EVERYTHING PNEUMATIC

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THE NEW YORK SANDHOG

New York City would seem to be the special and only permanent habitat of the sandhog. Incidentally and occasionally his services are apt to be called for anywhere in the world, but when the special task is done that ends it for that locality, while in the metropolis and its environs there is always something doing in his line.

He has laid the foundations for the four magnificent bridges, has driven nearly a score of tunnels under the two rivers, the great Catskill aqueduct has not been completed without his aid, and all the tall office buildings of lower Manhattan are primarily the monuments of his strenuous industry. On a succeeding page we reproduce an interesting and eminently readable article from the Evening Post, of New York, which deals with the latter phase of his employment.

There stands to-day in a central position in the City of New York one of the most notable buildings in the world not alone in the fact that it is the tallest building ever erected by man and put to practical service in its entirety. It is one of the most beautiful buildings in the world, as doubtless will in time be widely recognized. Perhaps the most notable thing about the building is the comprehensive reach of skill and invention which have made its erection possible, and which are embodied in its details of design and construction and in its various adaptabilities. Very different is the job of the sandhog in the caisson in baring and leveling off the rock surface when it is reached, and then in laying the concrete filling of the caisson which is eventually to sustain the weight of the vast superstructure, very different is his work from that of him who gilds the topmost pinnacle, and between these two all the constructive trades and most of the decorative arts have found numerous employment.

The range of vertical depth which limits the sandhog's working possibilities is scarcely over 100 feet. His special services are not called for in a downward direction until water level is reached, and human endurance, with any margin of safety ends at an air pressure of about 50 lb. gage. It is quite remarkable that practically all the calls for sandhog work in New York and its environs are within the sandhog limits. These were

not exceeded in the various tunnel enterprises or in the bridge foundations, and if, as seems not impossible, all of lower Manhattan is to be covered with lofty buildings which must have rock foundations the sandhog will be able to guarantee them.

There is just one stunt which the New York sandhog must decline. The bridging of the Hudson would be a vastly cheaper and easier proposition if a pier could be placed in the middle of the river, but the rock lies far too deep and calls for a rooter who has not yet appeared.

AMERICAN ENTERPRISE AND THE ROGLER VALVE FOR AIR COMPRESSORS

There is a distinguished American firm that makes, among other things, air-compressors. It established an office in Johannesburg and supplied air-compressor equipments to virtually all the mines in South Africa. It established an office in Germany and sold air-compressors there.

American air-compressors were standard, German air-compressors were primitive. But the German scholar who gives his life to a verb is reinforced nowadays by the German scholar who yearns to devote the whole mundane career of his immortal soul to a valve. German air-compressors grew better and bolder till they took the German market Then they carried the war into Africa; and the time came when the Transvaal mines were equipped with air-compressors not from American and not from English but from German workshops.

This triumph was not merely commercial. It was not achieved merely by manufacturing a sales campaign. It was achieved principally by designing a valve. The German air-compressors, as described by the American firm whose experience we are here recounting, "were the result of a long period of scientific study by German engineers who succeeded in producing what are known as 'plate' valves (for both steam and air ends of compressors) which have resulted in very high efficiencies."

So, through a technical inquiry which the United States could not prevent, Germany came to a leadership in certain elements of air-compressor design.

What then did our American firm do? It did what, if done in similar cases by all American firms, would keep us continuously at the tip of the wedge of progress. It determined to take instruction wherever instruction could be found. Its method was singularly vigorous. Instead of importing German books and German drawings, fragments of German knowledge, it engaged, as special adviser, a German professor who comprehends all that there is in the books and in the drawings, and more.

This scholastic assemblage of air-compressor progress, who lives in academic shades cast by chimneys instead of by trees, a man as much of alert practice as of studious research, now comes to us with air-compressor lessons from a country which, only a generation ago, was an air-compressor pupil of ours—and a backward one.

Brains of full human weight are being flung at the problem of invention on that side, as well as on this side, of every sea and of every national boundary-line in the civilized world. The nation that wishes to lead must everlastingly study the accomplishments of other nations; and humility becomes an important mental trait for international success.—*William Hard in Everybody's Magazine, December.*

AIR WASHING AND ITS RESULTS*

Clean air in motion and of proper temperature and humidity is necessary to indoor comfort. Our concepts of ventilation are undergoing a change. Slight reduction in the amount of oxygen or slight increases in the amount of carbolic acid in the air we breathe are no longer feared. The human body can automatically adapt itself to slight changes in the proportion of these gases. It is more difficult for the body to adapt itself to temperature changes, and these may cause more or less discomfort and damage. The heat relations of the body are complicated, involving heat production within the body, affected by food and by physical and mental exercise; heat transference within the body from the interior to the surface; and heat elimination at the surface, for human beings live normally in

*From a paper at the International Congress of School Hygiene, Buffalo, Aug., 1913, by George C. Whipple and Melville C. Whipple.

an atmosphere cooler than the body. Heat elimination is itself a complicated matter: it is lost by conduction, by convection, by radiation; it is affected by the temperature and humidity of the air, by the clothing worn, by the perspiration produced and evaporated.

We know at a matter of universal experience, that it is uncomfortable to remain in air that is still, or, as we say, that is "dead." If the air that we exhale remains so near our faces that we rebreathe a portion of it at each succeeding breath, a feeling of oppression and discomfort ensues. Air stagnation also forms an atmospheric cloak about our bodies which affects their heat conditions. Mere stirring of air often changes disconfort to comparative comfort. No system ot ventilation can be regarded as satisfactory that does not cause a sufficient circulation of the air.

Another thing that we need to appreciate is that the air that we breathe should be clean. Of course, the extremes of this quality of cleanliness have been recognized. We know that people who work at dusty trades, in dust-laden air, sicken and die of diseases that gain a foothold in the lungs; and we send our sick to the mountains and the seashore, and spend our vacations in the relatively clean air of the woods and fields and upon the water. From time immemorial water that is grossly foul has been regarded as dangerous, but it is only within a generation or so that water which is only moderately contaminated has been regarded as dangerous. If precedent is followed, we shall come to regard as undesirable much of the air that would not by present-day standards be called unclean, as well as air that is grossly laden with dust and foul gases.

LOCATION OF FRESH-AIR INLETS

Too little attention has been paid in the past to the cleanliness of the air supplied to our buildings. Fresh-air inlets are often located with the grossest disregard for the quality of the incoming air.

The fact of forcing unclean air into buildings is to nullify the result aimed at by ventilation. The presence of dust, bacteria and odors not only renders the conditions uncomfortable and deleterious to health, but it results in attempts at window ventilation, and this means poor ventilation, unequal heat distribution and draughts.

Supplying buildings with unclean air may often be obviated by a judicious choice of location for the inlet duct.

Crowded buildings and dusty city streets will often render it impossible to secure clean air from the outdoor atmosphere without resorting to artificial purification. Just as unclean water may be made wholesome by the employment of Nature's process of filtration, so can unclean air be purified by the application of another efficient process of Nature—namely, air-washing. The purifying effect upon atmospheric air of a heavy fall of rain is well known. A shower is said to freshen the air. Not cnly are suspended particles removed, such as dust and bacteria, but gaseous impurities, such as acids and ammoniacal vapors, are dissolved and removed, leaving the air sweet and clean.

HOW THE AIR IS WASHED

The process of air-washing consists of passing the air horizontally through a chamber in which water is falling in drops, as rain, or into which it is sprayed. The sprays are obtained by forcing the water out of perforated pipes or through nozzles placed across the ducts. When the sprays intersect they are said to form a curtain. Besides the washing chamber there are heating or tempering coils in the ducts or in a separate chamber, and devices for controlling temperature, a primary object of air-washing in the past having been that of conditioning the air with respect to its temperature and humidity. The water used for washing is circulated by means of a pump, so that it may be used over and over in the spray chamber for a considerable time. If desired this water may be cooled so as to influence the temperature of the air.

Comparison of the dust counts in the air before and after passing through the water showed that in the case of the five Boston washers the percentage removal ranged from 27 per cent. to 87 per cent., and averaged 54 per cent., while the removal of bacteria ranged from 37 per cent. to 88 per cent., and averaged 64 per cent. Generalizing from the data obtained, it is fair to say that the air-washing process as practiced romoved about two-thirds of the suspended particles—including dust, bacteria and molds.

From a comparison of the analyses of the tap water before use with the washer water after use, it is evident that many substances were removed from the air besides dust and bacteria. When street air was passed through a washer, it required but a few hours to resemble sewage in appearance and analysis.

The presence of sulphurous acids in the air of the business district of Boston was responsible for an interesting phenomenon. These acids resulted from the formation of sulphurous gases during the combustion of coal and, being soluble, were removed from the air and dissolved by the water in the air-washing process. As long as the water contained alkalinity the sulphuric acid was neutralized, but after a certain length of time an excess of acid was present. This condition was found in several washers. Where it occurred in a washer constructed largely of copper, the acid dissolved this metal and formed copper sulphate. As a resut, there was established a sort of automatic process of disinfection, and the numbers of bacteria found in the washer water were very low.

A SAVING OF HEAT IN COLD WEATHER

The advantage of washing and recirculating the air lies in the great saving of heat in cold weather. Mr. D. D. Kimball, who designed the ventilating plant at Springfield, estimated that when the out-door temperature was 32° F., the saving in cost of operation effected by recirculating washed air was 40 per cent., while with an outdoor temperature of 0° F., the saving was 50 per cent. The use of less coal at Springfield, when the air was being recirculated instead of being drawn in from outdoors, was plainly evident and was commented upon by the engineer in charge of the Springfield plant. In the summer the washer may be operated as a cooling plant to keep down the temperature of the indoor air, or with the windows open it may be shut down to save expense.

The common standard of 30 cubic feet of air per capita per minute, which is now generally applied to schoolhouses, was based upon the idea of keeping the carbonic acid down to a fixed amount. When it became recognized a few years ago that carbonic acid was a negligible factor, some made the inference that a smaller volume of air would suffice. They failed to consider that circulation of the air is of itself one of the essential elements of indoor comfort and a necessary feature of good ventilation.

THE SANDHOG AND THE SKYSCRAPER

The constant multiplication of tall office buildings in New York City has served somewhat to blunt the sensibilities to the enormity of the enterprises as they are completed. Yet even the most disinterested cannot help gazing upward occasionally with something of a thrill of appreciation, while buildings are under construction and the huge steel skeleton is working skyward. It is no longer a strange sight to see a workman swinging far out into space, so far aloft as to seem a mere insect clinging to a tiny thread. All know that he is mounted on a great steel beam that is on its way upward and that the thread he clings to is really the heaviest of steel cables and chains.

The "rough neck," as the steel-worker is called, shares with the underground worker, the "sandhog," the most perilous occupation on the construction work. The "rough neck's" work is spectacular and dangerous, but much that would be of interest to the ordinary observer goes on before the steel frame tops the high board fence which shuts off the view from the excavation. The passerby seldom enjoys more than a glimpse beyond the fence. If he ventures to peek through a crack or pause at a gateway he is invited to move on by a grim guardian armed with the big stick of temporary authority.

So it happens that little is generally known of the "sandhog," whose work begins at the surface and continues downward until somewhere far below his shovel strikes the solid surface of bed rock, upon which to rest the supports that will carry the great building, whose towers will reach toward the clouds.

WHERE ROCK IS FOUND.

The rock formation of lower Manhattan is somewhat peculiar. It has hills and valleys, entirely independent of conditions on the surface. At about Chambers Street, there is a decided valley in the rock. From this point northward, it begins to grade upwards, and crops out close to the surface at streets in the vicinity of the Twenties. Southward from Chambers Street, there is a rise again, and

solid rock is found nearer the surface at the Battery than at any place in lower New York.

When the Municipal Building was being erected, announcement was made that its foundations were planted deeper than those of any other building in the city. The excavation was carried to a depth of approximately 140 feet before bed rock was encountered. An official of the Thompson-Starrett Company, builders of the Municipal Building, states that the structure rests directly over the rock valley mentioned, and accounts for the great depth it was necessary to go to find proper footings.

For the new Equitable Building, which will, when completed, be the largest office building in the world, a bed-rock footing for its future thirty-six stories of masonry was found at a depth of approximately 83 feet below street level. The foundation wall is 6 feet thick and extends 936 feet all the way around the great excavation. This wall extends upward from bed rock about 55 feet, where the building wall proper will rest upon it.

The foundation was built in sections and then locked together. Each caisson section is six feet wide and twenty-five feet long, and a foreman and six "sandhogs" were employed in each under section. A strong air pressure was used to keep the water from driving the men out. Varying pressures of air were used up to twenty-five pounds to the square inch. Under such a pressure, experienced workmen can dig and drill for several hours at a stretch without injury. Under heavier pressure the shifts are shortened materially.

Caissons are equipped with a shaft about three feet in diameter, through which a bucket runs up and down, removing the earth as it is loaded below and serving as an elevator to take the workmen in and out. Two men usually ride in the bucket at once. The bucket, when loaded with passengers, is stopped in a lock at the top of the shaft. Here the air pressure is gradually increased to equal that below, if the bucket is going in, or diminished to normal, if the bucket is on the way out.

DANGER AND PRECAUTIONS.

Two men are continually on watch above ground, when there are men below. One is the lock-tender, who operates the lock at the top of the shaft, and the other the gauge-tender, who watches the air pressure. The engineer of the hoisting engine is also an important link for he must control the lightning-like wind of the cable around the drum in order to prevent any accidents to the bucket as it rushes up and down. An air-pressure whistle operated from below gives the signals to the lock-tender. He repeats back the signals by hammer taps on the metal shaft.

The signals vary according to the prearrangement of the working crew, but they operate somewhat as follows: Bucket down, 1. Bucket up, 3. Man coming up, 4. Danger is usually 5 toots of the whistle. Two is seldom used because liable to be confused with 1. All signals are given in multiples of 2 so that a call of 5 would be 2 toots—pause—2 toots—pause—then 1 toot.

Caissons were used only on the outside foundation walls or cofferdam of the Equitable building. The entire outside wall was completed to bedrock, and then powerful pumps sucked all the water out of the earth inside the walls. Pillar excavations are now being made without the use of air pressure, and only sheet piling or planking is necessary as a lining to the holes to prevent cave-ins.

A good many questions have been asked by the curious about the great boiler-like tube labelled "Hospital Lock," which is placed at the street level, wherever air-pressure work is in progress. This lock is required by law, and it is so constructed that a sick or injured workman can be put back under air pressure when brought up hurriedly from below. To take the air too suddenly or to be released from it too soon is exceedingly dangerous. Sudden changes of air pressure are responsible for "the bends," a dreaded, paralytic affliction of the underground worker. A patient suffering from an attack of this must be put back under air pressure for awhile and released from it gradually. All of which goes to show how interesting and important is the work of the "sandhog." He has surely come into his own and he is a busy man nowadays. —*The Evening Post,* New York.

So-called artificial lava is a newly patented mixture designed for heat and electrical insulation. Talc and magnesium silicate are heated to about 1850 deg. Fah., and while in a semi-molten condition the mass is shaped under high pressure.

NOTES

A village for workmen who will construct the Rogers Pass Tunnel on the Canadian Pacific Railway at Glacier, is to be built. On account of the heavy drifting snow, the houses will be elevated on stilts about 10 ft. above the ground and connected by bridges.

The injection of sugar into the veins of patients apparently dying from heart failure and exhaustion from various diseases, not only restores heart action, but produces a remarkable improvement in the general condition. Such is the substance of a communication from Dr. Enriquez of the Hospital de la Pitie, to the Academy of Medicine. The results in many cases are said to have been almost miraculous. No ill effects were shown.

If compressed air is handy, make an atomizer for spraying the soapsuds on the milling cutters used in the Lincoln miller. All that is needed is a ¼-in. gas T, a piece of ¼-in. pipe long enough to reach into the lubricant trough around the table when the cross part of the T is on a level with the cutter. Another piece of ¼-in. pipe with a ¼-in. globe valve screws into one side of the T and serves as a connection for the air, which should be at about 8 to 12 lb. pressure.

The address of the Weber Subterranean Pump Company, whose pump was described in our January issue, is 90 West Street, New York City.

Tufbrec is the name of a new building material recently discovered at Mount Angel in this state. The deposit covers hundreds of acres. It is composed of fragments of rocks of volcanic formation, and because of its numerous dead air cells is said to make an ideal fire and sound proof material.

One of the longest railway tunnels in North America is to be built for the Canadian Pacific Ry. The tunnel is located in the Canadian Rockies near Rogers Pass. It will have a total length of about 28,000 ft. Its purpose is to lower the summit level and improve the grades and alignment of the Rogers Pass division.

One of the recent developments in refrigeration is the use of "oxygenized ice," which is made simply by adding peroxide of hydrogen to the ice while it is forming. This ice is slightly tinted with some soluble dyestuff, and is used only for refrigeration purposes without contact with food products.

In a new German refrigerator, comprising the usual insulated chest with an ice compartment on top, the air is drawn out of the refrigerating space and forced over the ice by means of a motor driven air pump. The air after being thus cooled is again driven into the refrigerating space, and so on continuously.

The following is from one of our exchanges which shall be nameless:

"When using a pump during shaft-sinking, the disposal of the exhaust air or steam sometimes causes trouble. To overcome this, and have a quiet shaft and less annoyance to the miners, it is a good plan to exhaust into the water column going to the surface or elsewhere." If they would only tell us just how they do these funny stunts!

The Columbus Oil & Fuel Co., subsidiary to the Columbus Gas & Fuel Co., Columbus, O., will arrange to secure a supply of gas from West Virginia fields. It has acquired gas and oil rights on 125,000 acres, and has options on 75,000 acres additional, said to require an immediate investment of $400,000. The proposed line will include 90 miles of 16 or 18 inch pipe, 30 miles of 12 inch and 90 miles of 10 inch, with an approximate total cost of $2,000,000.

At least 100 cubic feet of air per minute should be allowed for each man in the mine and 500 feet per minute for each animal. In the anthracite district of Pennsylvania 200 cubic feet per minute is required. If the mine makes inflammable gas, there should always be allowed at least 150 cu. ft. of air per minute for each person. There should be a separate split of air for every 50 to 100 men, depending on the laws in force in the state where the mine is located. By this provision, air is supplied without excessive velocity and the products of an explosion in one section may not invade another.

It is estimated that all the steam plants in the United States produce a total of 16,000,000

hp., while the 1,000,000 gasoline automobiles in use, averaging 25 hp. each, have a total output of 25,000,000 hp. In addition to this there is 15,000,000 hp. generated by motor boats. This brings the total energy developed by movable gasoline engines in the country up to 40,000,000 hp., not including the utilization of this form of power on the farm. An estimate for 1913 places the consumption of gasoline for automobiles alone at 17,000,000 barrels, and no one dares seriously to ask how long the supply will last. We may always console ourselves with the belief that something else will come along.

An electrically operated device for measuring gas, and having a capacity of 100,000 cubic feet per hour, is being used by the Citizens' Gas and Electric Company, of Waterloo, Iowa. The action of this meter is dependent on the electrical heating of the gas in passing through the measuring chamber. The temperature of the gas before and after passing the "heating grid" is measured by two electrical resistance thermometers, which, by means of a relay, adjust the grid current so as to maintain a constant difference of temperature. This current is thus a measure of the amount of gas passing through the grid, and is measured by an ordinary watt-hour meter calibrated directly in cubic feet of gas. An electrical chart recorder is also installed on the meter panel, and gives a record of the rate of flow of the gas.

A lecture was recently given to the Birmingham Metallurgical Society by Mr. Alex. E. Tucker, F. I. C., on "Recent Improvements in Welding," in which the conditions for successful welding were discussed. Mr. Tucker showed that the thermit process, in which aluminium powder was used, was of great use in the Russian-Japanese war, and had been the means of repairing extensive damage done to the Russian fleet. The replacement of acetylene by hydrogen in the cutting and welding of steel was also discussed. Mr. Tucker pointed out that the difficulties of making successful welds with acetylene in the case of parts of engines and machines was very great. There was always the risk of carbonisation on the one hand and oxidation on the other. This was not the case when hydrogen was used, and modern practice showed the reality of these objections.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 2.

1,079,935. HUMIDIFIER. Clarke S. Drake, Milwaukee, Wis.

1,079,985. FLUID PRESSURE REGULATOR. Julius M. Kaminsky, Indianopolis, Ind.

1. In a regulator of the flow of fluid, the combination with a conduit, of a spring coiled longitudinally therein and normally expanded with one end surrounding the passage of the fluid, so that the fluid must flow through the convolutions thereof, and a head on the other end of the spring constructed to give a passage for fluid past it of a constant caliber which is greater than that of the passage through the convolution of the spring during the period when the flow through the regulator is being changed.

1,080,063. AIR-COMPRESSOR. Ebenezer Hill, Norwalk, Conn.

1,080,095-6. PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,080,106. SPRING AND PNEUMATIC WHEEL. Joseph A. Gray, Norwalk, Conn.

1,080,164. PNEUMATICALLY - ACTUATED MUSICAL INSTRUMENT. August Phillips, Frankfort-on-the-Main, Germany.

1,080,168. GLASS BLOWING MACHINE. John Rau, Indianapolis, Ind.

1,080,170. AIR-GUN. Ernest S. Roe, Plymouth, Mich.

1,080,198. DEHYDRATING APPARATUS. Ernest William Cook, New York, N. Y.

1,080,289. COMBINED AIR MOTOR AND COMPRESSOR FOR STARTING INTERNAL COMBUSTION ENGINES. Harry A. Lord, South Pasadena, Cal.

1,080,322. DISCHARGE-VALVE. Albert L. Brown, Little Rock, Ark.

1. In a compressor, the combination with a cylinder, of a reciprocating discharge valve, a sleeve for guiding the valve, a cap on said sleeve, a removable member extending above the top of the compressor and down into said sleeve, said member fitting said cap and having a restricted passage opening above and below the cap, whereby said valve is cushioned as it moves to its seat by the formation of a partial vacuum in the sleeve behind the valve.

1,080,420. VACUUM CLEANING APPARATUS. James P. Clifton, Buffalo, N. Y.

1,080,452. APPARATUS FOR CONTROLLING AIR AND OTHER GAS COMPRESSORS. Gustave E. Huttelmaier, Scottdale, Pa.

2. Apparatus for controlling the operation of gas compressors comprising mechanism for stopping the operation of the compressor, means for holding said mechanism in inoperative position and means actuated by an increase in temperature above a predetermined limit of the gases being compressed for releasing the holding means and stopping the operation of the compressor.

1,080,469. VACUUM SYRUPING-MACHINE. Willis Grant Murray, San Francisco, Cal.

1,080,471. AIR-GAS APPARATUS. Svend Olsen, Halle-on-the-Saale, Germany.

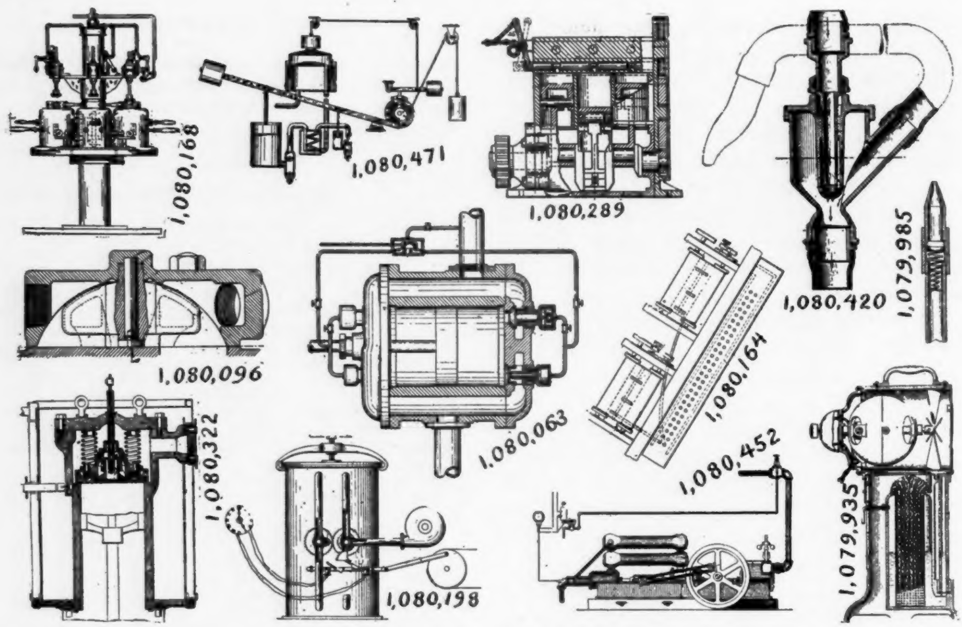
DECEMBER 9.

1,080,538. PNEUMATIC DISPATCH-TUBE CARRIER. Roderick G. Collins, Jr., New York, N. Y.

1,080,582. REGULATOR FOR FLUID-PRESSURE APPARATUS. Auguste Camille Edmond Rateau, Paris, France.

1,080,594. DEVICE FOR SPRAYING LIQUID INTO AR. Gustav Adolph Schuller, Venusberg/Erzgebirge, Germany.

1,080,706-7. ROCK DRILL. Edwin M. Mackie and Percival F. Doyle, Franklin, Pa.



PNEUMATIC PATENTS DECEMBER 2.

1,080,737. AIR-COMPRESSOR. WILLIAM EVERETT VER PLANCK, Erie, Pa.

1,080,743. ROTARY COMPRESSOR. KARL AHLQUIST, Rugby, Eng.

1,080,773. ENGINE-STARTER. CHARLES H. MYERS, Buffalo, N. Y.

1,080,843. DEEP-WELL AIR-PUMP. WILLIAM L. MORROW, Los Angeles, Cal.

1,080,853. PNEUMATIC TYPE-WRITER. MAX SOBLIK, Dresden-Klotzsche, Germany.

1,080,880-1. PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,080,884. REVERSING-GEAR FOR ENGINES. WINZOR A. BIRCHETTE, Detroit, Mich.

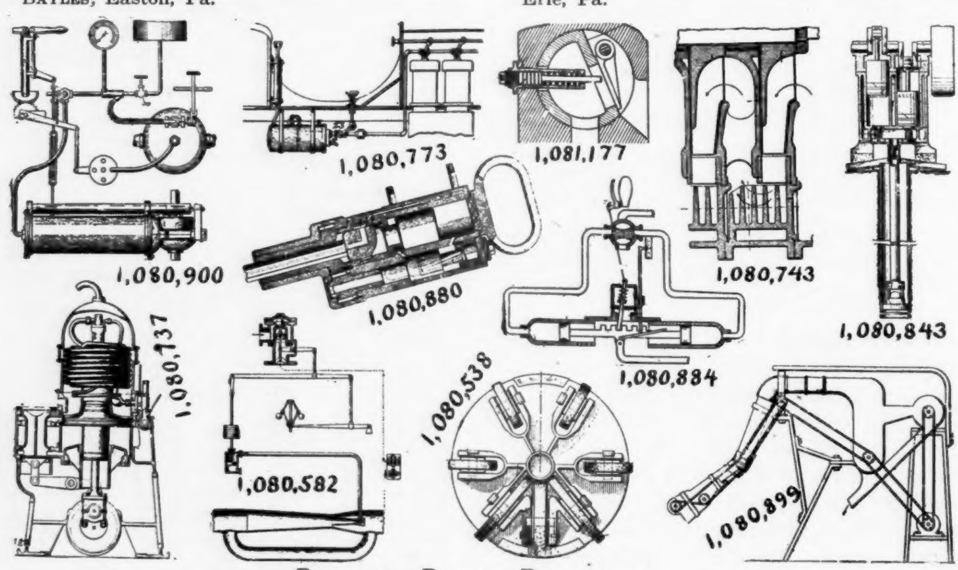
1,080,899. COTTON-PICKER. JAMES W. DINSMORE, Lookeba, Okla.

1,080,900. ENGINE-STARTING MECHANISM. JOHN H. DURNO, Rochester, N. Y.

1,081,020. PUMP. WILLIAM COYNE, Kewanee, Ill.

1,081,175-6. FLUID-COMPRESSOR. CHARLES WAINWRIGHT, Erie, Pa.

1,081,177. GOVERNING DEVICE FOR FLUID-COMPRESSORS. CHARLES WAINWRIGHT, Erie, Pa.



PNEUMATIC PATENTS DECEMBER 9.

DECEMBER 16.

1,081,316. AIR-BRAKE SYSTEM. GEORGE MACLOSKIE, Schenectady, N. Y.

1,081,325. FLUID-PRESSURE BRAKE. GEORGE OPPERMANN, Hanover, Germany.

1,081,347. PRESSURE-RETAINING-VALVE DEVICE. WALTER V. TURNER, Edgewood, Pa.

1,081,377. COMPRESSED-AIR LOCOMOTIVE. JOHN A. FORSYTH, Fredericktown, Pa.

1,081,436. METHOD OF AERATING SOLUTIONS. WILTON E. DARROW, Amador City, Cal.

A process of aerating a cyanid solution consisting in forming the said solution into a film and admitting air under pressure into contact with said film, as described.

1,081,441. PNEUMATIC-DISPATCH-TUBE APPARATUS. EDMOND A. FORDYCE, Boston, Mass.

1,081,443. ELASTIC-FLUID ENGINE. WILLIAM A. GODFREY, Boston, Mass.

1,081,483. PROCESS OF STERILIZING MILK. CHARLES E. BONINE, Philadelphia, Pa.

1. The process of sterilizing milk, consisting in heating the milk to sterilizing temperature, agitating the milk during heating and maintaining, during heating, a surface pressure on the milk in excess of the normal vapor pressure of the milk.

1,081,523. DEVICE FOR MODIFYING THE PHYSICAL STATE OF AIR. FORTUNATO BERARDI, Naples, Italy.

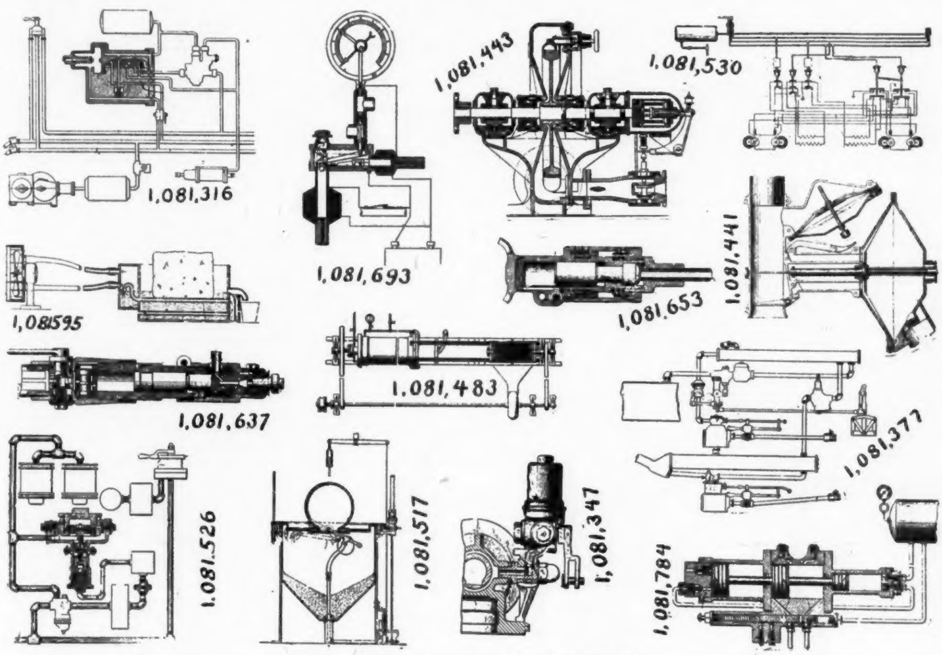
1,081,526. FLUID-PRESSURE MAINTAINING SYSTEM. FRANK H. DUKESMITH, Buffalo, N. Y.

1,081,547. SAND-BLAST MACHINE. CHARLES F. MOTZ, Monaca, Pa.

1,081,550. ELECTROPNEUMATIC BREAKING SYSTEM. WILLIAM C. MYERS, Oakland, Cal.

1,081,595. AIR-COOLER. ARTHUR ELSON, Boston, Mass.

1,081,603. PNEUMATIC PIANO. CHARLES FREBORG, Kankakee, Ill.



PNEUMATIC PATENTS DECEMBER 16.

1,081,613. VULCANIZED CAOUTCHOUC AND PROCESS OF MAKING SAME. FRITZ HOFMANN and KONRAD DELBRUCK, Elberfeld, Germany.

The herein described new material being a vulcanized autopolymerization product of beta-gamma-dimethylbutadiene combined with a small amount of a basic substance, being a whitish non-adhesive substance, containing sulfur, and which on *treatment with ozone,* forms an ozonid which upon decomposition with water yields among its decomposition products acetonylacetone.

1,081,637. HAMMER-DRILL. ALBERT H. TAYLOR, Easton, Pa.

1,081,653. PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,081,693. ELECTRIC PNEUMATIC-PRESSURE CONTROLLER. EDWARD K. PARKER, Santa Barbara, Cal.

1,081,784. AUTOMATIC PUMP. GREGORY JOHN SPOHRER, Franklin, Pa.

DECEMBER 23.

1,082,113. PNEUMATIC CONVEYOR. EDWARD THOMPSON DIDEN, Prattville, Ala.

1,082,156. COMPRESSOR FOR AIR AND GAS. JOSEPH HENRY HURST, Sheffield, England.

1,082,159. ATOMIZER. GEORGE J. KELLEY, Attleboro, Mass.

1,082,162. ROCK-DRILLING-STOPING-DRILL. JOHN GEORGE LEYNER, Denver, Col.

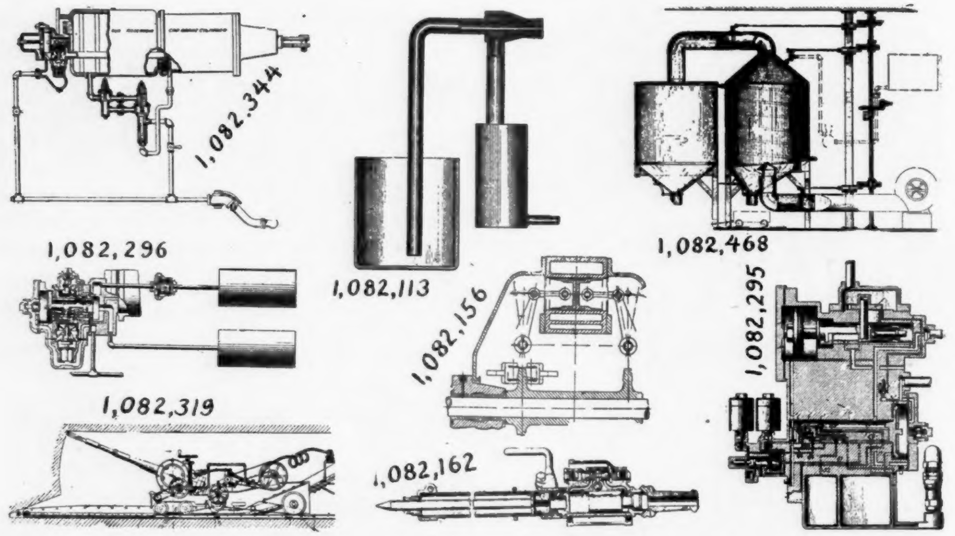
1,082,295. ELECTROPNEUMATIC CONTROL-VALVE MECHANISM. WALTER V. TURNER, Edgewood, Pa.

1,082,296. FLUID-PRESSURE BRAKE DEVICE. WALTER V. TURNER, Edgewood, Pa.

1,082,318-9. MINING-MACHINE. ARTHUR H. GIBSON, Easton, Pa.

1,082,344. APPARATUS FOR THE RECHARGING OF AUXILIARY RESERVOIRS OF AIR-BRAKE SYSTEMS. HARRY TILGHMAN KLECKNER, Shamokin, Pa.

1,082,468. APPARATUS FOR DESICCATING. LEWIS C. MERRELL, Syracuse, N. Y.



PNEUMATIC PATENTS DECEMBER 23.

DECEMBER 30.

1,082,492. DEVICE FOR DISTRIBUTING AIR. ADOLPHE E. BOSSE, Pittsburgh, Pa.

1,082,501. EXCAVATING MACHINE. WALTER G. CLARK, New York, N. Y.

1,082,568. VACUUM-PRODUCING DEVICE. HUSTON TAYLOR, Rochester, N. Y.

1,082,580. FLUID-POWER HAMMER. RALPH E. BATES, Philadelphia, Pa.

1,082,595. STARTING DEVICE FOR MOTOR CARS. JUSTUS R. KINNEY, Dorchester, Mass.

1,082,594. IMPELLING DEVICE FOR FLUID-CIRCULATING SYSTEMS. GEORGE W. KERN, Oil City, Pa.

1,082,666. REGULATOR FOR A PNEUMATIC CIRCUIT. FRANK C. WHITE, Meriden, Conn.

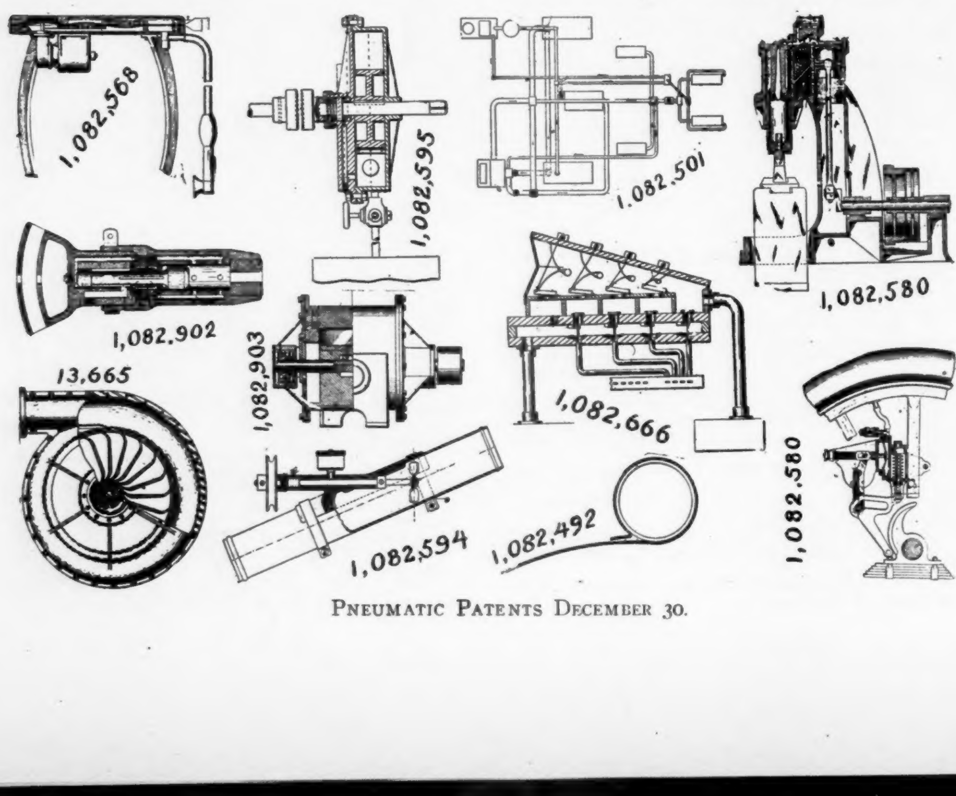
1,082,758. TRIPLE VALVE FOR AIR-BRAKES. SPENCER G. NEAL, Los Angeles, Cal.

1,082,902. RECRIPROCATING ENGINE. EDWIN A. PERKINS, New York, N. Y.

1,082,903. ROTAR BLOWER OR PUMP. LOUIS N. PERKINS, Connersville, Ind.

1,082,983. TIRE-INFLATED MECHANISM. EDWARD J. WATSON and RICHARD F. DOWNEY, Milwaukee, Wis.

13,665. (Reissue). CENTRIFUGAL COMPRESSOR. SANFORD A. MOSS, Lynn, Mass.



PNEUMATIC PATENTS DECEMBER 30.